

The Rothamsted Monographs on
Agricultural Science

MANURING OF
GRASS LAND FOR HAY

W. E. BRENCHLEY



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

Station -
Agricultural
1.00.

THE ROTHAMSTED MONOGRAPHS ON

AGRICULTURAL SCIENCE

EDITED BY

SIR E. JOHN RUSSELL, D.Sc. (LOND.), F.R.S.

MANURING OF GRASS LAND FOR HAY

THE ROTHAMSTED MONOGRAPHS ON AGRICULTURAL SCIENCE.

EDITED BY SIR E. JOHN RUSSELL, D.Sc., F.R.S.

DURING the past ten years there have been marked developments in knowledge of the relations between the soil and the growing plant. The subject involves physical, biological, and chemical considerations, and its ramifications are now so wide that they cannot be satisfactorily dealt with in detail in any one book. These monographs collectively cover the whole ground. In "Soil Conditions and Plant Growth" the general outlines are presented : in the monographs the various divisions are fully and critically dealt with by the Heads of the Departments concerned at Rothamsted. A homogeneous treatment is thus secured that will, it is hoped, much facilitate the use of the series.

SOIL CONDITIONS AND PLANT GROWTH, Fourth Edition.
By Sir E. JOHN RUSSELL, F.R.S. 16s. net.

MANURING OF GRASS
LAND FOR HAY. . . By WINIFRED E. BRENCHEY,
D.Sc., F.L.S.

THE MICRO-ORGANISMS
OF THE SOIL . . . By Sir E. JOHN RUSSELL, F.R.S.,
and Members of the Biological
Staff of the Rothamsted Experimental Station.

The following volumes are in preparation :—

SOIL PHYSICS . . . By B. A. KEEN, D.Sc.
SOIL PROTOZOA . . . By D. W. CUTLER, M.A., and
L. M. CRUMP, M.Sc.
SOIL BACTERIA . . . By H. G. THORNTON, M.A.
SOIL FUNGI AND ALGÆ . . . By W. B. BRIERLEY, D.Sc., S. T.
JEWSON, M.Sc., and B. M.
ROACH (Bristol), D.Sc.

CHEMICAL CHANGES IN
THE SOIL . . . By H. J. PAGE, B.Sc.

LONGMANS, GREEN AND CO.,
LONDON, NEW YORK, TORONTO, BOMBAY, CALCUTTA AND MADRAS.

Agric.
Soil
B.

MANURING OF GRASS LAND FOR HAY

BY

WINIFRED E. BRENCHELEY, D.Sc.

ROTHAMSTED EXPERIMENTAL STATION
FELLOW OF UNIVERSITY COLLEGE, LONDON

WITH DIAGRAMS

193717
23.1.25

LONGMANS, GREEN AND CO.

39 PATERNOSTER ROW, LONDON, E.C. 4

NEW YORK, TORONTO

BOMBAY, CALCUTTA AND MADRAS

1924



Made in Great Britain

PREFACE.

THE question of hay production is of such moment to the agriculturist that much importance attaches to information concerning the factors that determine the yield from grass laid up for hay, together with the botanical composition and consequent feeding value of the herbage. Lawes and Gilbert recognised this when they laid out the Park Grass Plots in 1856 to determine the relative effect of different combinations of manures upon hay production, and they eventually published the results of twenty years' continuous manuring. Since that time additional data have accumulated, particularly with regard to the effect of liming super-imposed upon the original manuring, and it has seemed advisable to set forth a brief summary of the results to date. The mass of facts and figures is so great that it has been necessary rigidly to compress and tabulate the material, in order to present the salient features without making the whole too unwieldy. Much that is of interest has perforce been omitted, but the yearly records themselves, with their wealth of detail, would provide a rich field for the plant ecologist to study the relations between the various species and plant associations, as determined by the different conditions of nutrition brought about by the various combinations of manures on the same soil and under identical climatic conditions.

The value of the work lies to a great extent in the length of time over which the experiments have been carried on,

as thereby the varying effects of season have been more or less cancelled out. A consideration of the yearly results over a prolonged period shows clearly the general trend of events, which is often obscured when short-term experiments are considered. The results as presented deal solely with the Rothamsted plots on heavy soil, and no attempt is made to compare them with other more or less similar work on different types of soil elsewhere. The real intention of the monograph, indeed, is to attempt to round off and complete the work begun by Lawes and Gilbert, in order to suggest possible lines along which future developments of experimental work on meadow land might profitably extend.

W. E. BRENCHLEY.

September, 1923.

CONTENTS.

CHAPTER	PAGE
I. INTRODUCTION—	
A. OUTLINE OF EXPERIMENT	1
B. OBJECT OF MONOGRAPH	2
C. METHODS OF SAMPLING AND ANALYSIS	3
D. MANURING AND PRODUCE PER ACRE (TABLE I.)	4
II. PHANEROGAMIC FLORA OF PLOTS	5
III. MOSS FLORA OF PLOTS	7
IV. EFFECT OF MANURES AND LIME—	
A. EFFECT ON INDIVIDUAL PLOTS	9
A. NO MANURE (TABLE II.)—	
1, 2. Unmanured since 1855 (Plots 3 and 12)	9
3. Unmanured since 1864, after Farmyard Manure (Plot 2)	16
4. Unmanured, after Ammonium Salts (Plot 5 ¹)	18
B. MINERAL MANURES (TABLES III. AND IV.)—	
5. Mixed Mineral Manure (Plot 7)	22
6. Mineral Manure without Potash (Plot 8)	26
7. Mixed Mineral Manure, after Ammonium Salts (Plot 6)	31
8. Mixed Mineral Manure, after Nitrate of Soda (Plot 15)	32
9. Superphosphate and Sulphate of Potash, after Ammonium Salts (Plot 5 ³)	36
10. Superphosphate of Lime (Plot 4 ¹)	39
C. NITRATE OF SODA WITH AND WITHOUT MINERAL MANURES (TABLE IV.)—	
11. Nitrate of Soda (Plot 17)	44
12. Nitrate of Soda (275 lbs. per acre) and Mixed Mineral Manure (Plot 16)	46
13. Nitrate of Soda (550 lbs. per acre) and Mixed Mineral Manure (Plot 14)	51

D. AMMONIUM SALTS WITH MIXED MINERAL MANURE (TABLE V.)—	
14. Ammonium Salts (400 lbs. per acre) and Mixed Mineral Manure (Plot 9) . . .	54
15. Ammonium Salts (400 lbs. per acre) and Mixed Mineral Manure without Potash (Plot 10)	58
16. Ammonium Salts (600 lbs. per acre) and Mixed Mineral Manure (Plot 11 ¹) . . .	61
17. Ammonium Salts (600 lbs. per acre) and Mixed Mineral Manure with Silicate of Soda (Plot 11 ²)	64
E. AMMONIUM SALTS ALONE OR WITH INCOMPLETE MINERAL MANURES (TABLE VI.)—	
18. Ammonium Salts alone, after Farmyard Manure (Plot 1)	68
19. Ammonium Salts and Superphosphate of Lime (Plot 4 ²)	71
20. Ammonium Salts and Mixed Mineral Manure without Superphosphate (Plot 18) . . .	75
F. ORGANIC MANURES (TABLE VI.)—	
21. Farmyard Manure and Fish Guano alternately (Plot 13)	78
22. Farmyard Manure every fourth year (Plot 19)	81
23. Farmyard Manure every fourth year, with Nitrate of Soda and Minerals in intervening years (Plot 20)	84
B. EFFECT ON INDIVIDUAL SPECIES—	
A. GRAMINACEÆ	87
B. LEGUMINOSÆ	118
C. MISCELLANEOUS SPECIES	124
V. SUMMARY	137
INDEX	145

CHAPTER I.

INTRODUCTION.

(A) OUTLINE OF EXPERIMENTS.

MANURIAL experiments on grassland on loamy clay soil have been carried on continuously at Rothamsted since 1856. In that year about 7 acres of the Park were selected and divided into twenty plots * (varying in area from $\frac{1}{2}$ to $\frac{1}{8}$ of an acre), two of which received farmyard manure, two were left unmanured, and the others received different combinations and amounts of artificial fertilisers. With certain exceptions the same manuring has been applied to each plot up to the present day. Wherever changes have been made they will be indicated in the detailed accounts of the individual plots. The area selected had been under grass for some centuries, and there is no record of any seed having been sown artificially since the grass was first laid down, so that at the beginning one was dealing with a natural herbage, which quickly responded to the action of the fertilisers used. After several years of experiment some of the plots began to show signs of lime deficiency, and in November 1883 fresh burnt lime at the rate of 2000 lbs. per acre was applied to the west half of each plot. Four years later, in 1887, a similar dressing was given to the east halves except on Plot 5, on which the second dressing was postponed till 1896. On plots 11¹ and 11², which showed much lime deficiency, a dressing of 4000 lbs. per acre was put on the east halves in 1887, and also 2000 lbs. on the west halves; the same amount of lime was applied to plot 5 in 1896. Thus ultimately every plot received a similar amount of lime over its whole area. In 1903 a fresh system of liming was instituted to demonstrate

* Three of these plots, 4, 5, and 11, have since been subdivided.

the effect of long-continued lime starvation; 2000 lbs. per acre of lime was applied to the south half of most plots, and the application was repeated in 1907, 1915, and 1920 (2500 lbs. per acre in 1920), the crops from each half plot being harvested separately.

The first crop of grass has been cut for hay every year, but until 1872 the aftermath was usually fed off with sheep penned on to each plot. On several plots the animals suffered, and as in addition the use of sheep introduced other factors than those associated with artificial fertilisers, this method was discontinued and the second crop was cut, made into hay whenever weather permitted, or else carted green and the equivalent quantity of hay calculated.

The results of the experiments for the first twenty years were most exhaustively worked out by Lawes, Gilbert, and Masters in their classical memoirs.*

(B) OBJECT OF MONOGRAPH.

The object of the present monograph is to indicate the position of affairs at the present day, to make comparisons with the earlier results, and to sketch out the changes in the vegetation induced by change in manuring during the experimental period. The effect of long-continued lime starvation will also be considered, comparison being made with areas on which lime compensation has been made. The mass of data available is so great that to avoid confusion it has been reduced throughout to a semi-tabular form, and the effect of manuring upon the total herbage and on the individual species is considered in two distinct sections of the book.

- * (a) Lawes, J. B., and Gilbert, J. H. (1880), "Agricultural, botanical and chemical results of experiments on the mixed herbage of permanent grassland, conducted for many years in succession on the same land," Part I. *Phil. Trans. Roy. Soc.*, Vol. 171, pp. 289-416.
- (b) Lawes, J. B., Gilbert, J. H., and Masters, M. T. (1882), *ibid.*, Part II. *Phil. Trans. Roy. Soc.*, Vol. 173, pp. 1181-1413.
- (c) Lawes, J. B., and Gilbert, J. H. (1900), *ibid.*, Part III. *Phil. Trans. Roy. Soc.*, Vol. 192, pp. 139-210.

(c) METHODS OF SAMPLING AND ANALYSIS.

Throughout the experiments notes have been made at intervals during the growing season, the weight of the first and second crops have been recorded, and a "partial separation" of samples of hay from certain plots has been made. The latter implies the division of the herbage into *Graminaceæ*, *Leguminosæ*, and *Miscellaneous orders*, enabling the relative percentage of each type of plant to be determined.

In addition, two "complete separations" have recently been carried out on the first crops of 1914 and 1919.* For this purpose the samples were most carefully taken. A gang of men walked behind the cutting machine, taking handfuls of grass from each swathe at regular intervals. This grass was thrown on to a large tarpaulin, and was then shifted back and forth to another sheet three times, care being taken to avoid tearing or breaking. The herbage was then spread out thinly, and small handfuls were taken here and there till a weighed sample of from 12 to 20 lbs. was obtained, according to the size of the grass. These samples were spread in the shade, and later were carefully tied up in sheets and transferred to the laboratory, where they were dried under cover and the weight of the hay determined. By sampling and drying in this way comparatively little breaking of the grass occurred, and the colour was well kept, both of which facilitated the later work and reduced the expense of separation. The samples were then sorted out leaf by leaf into their constituent species. The work was done by girls, and the separations were revised by the author and Miss Grace Bassil, the latter of whom undertook entire supervision in 1919. The "small stuff," consisting of seeds, small leaves, and broken pieces of leaves and stems, was first sorted out by sieves of various sizes, and then worked down as closely as possible; in this way the amount of undetermined matter from each plot was very small, and consisted chiefly of dust-like particles of leaves and tiny seeds that could not be

* A complete separation of certain plots was also made in 1903.

identified or separated. The greater care exercised in sampling in 1919 enabled the "undetermined" residue to be reduced considerably below that of 1914.

(D) MANURING AND PRODUCE PER ACRE.

For the purpose of reference, a table is appended giving the actual quantities of manures applied to each plot, and the average crops over ten-year periods throughout the experiment (Table I.). The figures are based upon the yields of the first crops only, as for several years after lime had been applied the second crops from the limed and unlimed halves of each plot were bulked, so that the necessary distinctions in the yield could not be drawn in the case of the aftermath.

CHAPTER II.

PHANEROGAMIC FLORA OF PLOTS.

Orders, Genera, and Species Represented.

A CHARACTERISTIC feature of grass land herbage is the large number of species that are represented. At the present time the flora consists of sixty-six species, contained in fifty-nine genera, and belonging to twenty-two orders (excluding mosses). This is a reduction of twenty species since the original separations in 1862-1877, though the number of orders and genera is almost the same. As a matter of fact, twenty-four species have actually disappeared, but four others, introducing three fresh orders, have come in. Every one of the species that has died out was originally present in very small quantity, and in most cases only on a single plot. *Phleum pratense* and *Carduus arvensis* were the only two that were found on several plots.

Every species that occurred in any appreciable quantity in the early days is still present, even though the amount may be small, and on the whole it is only the casuals or accidental introductions that have disappeared.

The species that have disappeared are :—

<i>Graminaceæ.</i>	<i>Festuca elatior.</i>
„	„ <i>lohiacea.</i>
„	<i>Phleum pratense.</i>
<i>Leguminosæ.</i>	<i>Trifolium minus.</i>
„	„ <i>procumbens.</i>
„	<i>Lotus major.</i>
„	<i>Vicia cracca.</i>
<i>Miscellaneous.</i>	<i>Ranunculus repens.</i>
„	„ <i>auricomus.</i>

Miscellaneous.	<i>Stellaria holostea.</i>
„	<i>Hypericum perforatum.</i>
„	<i>Daucus carota.</i>
„	<i>Galium aparine.</i>
„	<i>Carduus arvensis.</i>
„	<i>Senecio erucifolius.</i>
„	<i>Leontodon autumnalis.</i>
„	<i>Sonchus oleraceus.</i>
„	<i>Plantago media.</i>
„	<i>Veronica serpyllifolia.</i>
„	„ <i>officinalis.</i>
„	<i>Rumex crispus.</i>
„	„ <i>obtusifolius.</i>
„	<i>Orchis morio.</i>
„	<i>Ornithogalum umbellatum.</i>

The species that have come in are :—

Graminaceæ.	<i>Triticum repens</i> (only seen in 1914).
Miscellaneous.	<i>Linum catharticum.</i>
„	<i>Viola canina.</i>
„	<i>Epilobium sp.</i>

CHAPTER III.

MOSS FLORA OF PLOTS.

DURING the early years of the experiment only three species of mosses were recognised on the plots, being identified as *Hypnum squarrosum*, *H. rutabulum*, and *H. heans*. They were almost or entirely absent from most samples, being chiefly represented on the unmanured plots.

At the present time the mosses are more in evidence, specially during the winter months, comparatively few appearing in the hay. A moss survey was made on several occasions in the early months of 1921, and though very incomplete it gives an idea of relative distribution. In spite of careful search, it is not possible to be certain that every species present was detailed on each plot, and no attempt could be made to estimate the relative prevalence of each. For this reason the species are listed and are not associated with individual plots. It was noticeable that mosses were always plentiful on mole heaps, where these occurred, and that they were scarce on all plots where the grass started into growth early in the season.

Relative Quantities Present.

Plentiful.—

- | | | | |
|----------|-----------|------------|--------------------------|
| Unlimed. | 2, 3, 12. | No manure. | Scarce on limed portion. |
| | 6. | Minerals. | |

In small amounts.—

- | | | | |
|----------|------------------|-----------------------------|--------------------------|
| Unlimed. | 4 ¹ . | Superphosphate. | Scarce on limed portion. |
| | 5 ¹ . | Unmanured after amm. salts. | |
| | 5 ² . | Minerals after amm. salts. | |
| | 7. | Minerals. | |
| | 16. | Minerals + nitrate of soda. | |

Scarce or almost absent.—

On all other plots.

MOSSES ENCOURAGED BY—

(1) No manure.

(2) Minerals alone (to some extent).

MOSSES DISCOURAGED BY—

(1) Liming.

(2) Nitrogenous manures.

(3) Organic manures.

Species Present.*

Aulacomnium androgynum, Schwaegr.

Barbula unguiculata, Hedw.

„ „ „ var. (?)

Brachythecium purum, Dixon.†

„ „ *velutinum*, Br. and Schpr.

Bryum bimum, Schreb.

„ *intermedium*, Brid.

Campylopus flexuosus, Brid.

Ceratodon purpureus, Brid.

Dicranella cerviculata, Schpr.

„ *heteromalla*, Schpr.

„ *varia*, Schpr.

Eurynchium strigosum, Br. and Schpr.

Fissidens bryoides, Hedw.‡

Hylocomium squarrosum, Br. and Schpr.

Pottia lanceolata, C. Müll.

„ *truncatula*, Lindb.

Webera albicans, Schpr.

Weisia sp.

* Thanks are due to Miss K. Warrington for carrying out the survey, and to the Director of Kew Gardens for the identification of the species.

† Plentiful on plot 5¹, unmanured after amm. salts.

‡ Most abundant on plot 6, minerals only.

CHAPTER IV.A.

EFFECT OF MANURES AND LIME ON INDIVIDUAL PLOTS.

A. NO MANURE. (TABLE II.)

1. UNMANURED SINCE 1855. (PLOT 3.)

Present Condition of Plot (Unlimed).

(a) Herbage of a characteristic poverty-stricken type, yielding a very small crop, and consisting of a large number of species, of which few are strikingly in evidence in most

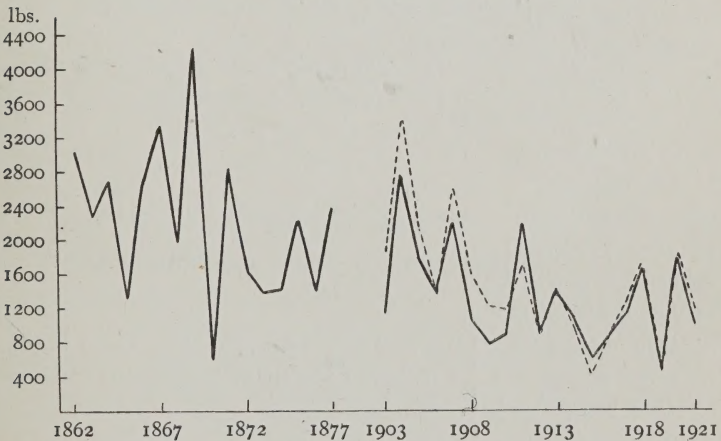


FIG 1.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 3.

— Unlimed. - - - - - Limed.

seasons. The plants are nearly all low growing, and tend to form leaves close to the ground rather than much top growth, giving a leafy hay.

- (b) Starts into growth late in spring.
 (c) Yield very low.
 (d) Thirty to forty species, subject to considerable seasonal fluctuations.
 (e) The three main groups of plants are all well represented, the proportion of *Graminaceæ* being low and very variable. The range, as shown by the partial separations from 1903-1919, was :—

	Lowest per cent.	Highest per cent.
G.* .	39·40 (1905).	67·56 (1910).
L. .	2·57 (1910).	12·70 (1904, 1908).
M. .	25·17 (1916).	54·54 (1912).

Main Constituents of Association on Plot 3.

- Festuca ovina* } Usually most abundant *Graminaceæ*.
Agrostis vulgaris }
Holcus lanatus } Occasionally among the three most
Dactylis glomerata } abundant *Graminaceæ*.
Anthoxanthum odoratum }
Avena pubescens.
Briza media.
Lotus corniculatus. Usually chief leguminous species.
Trifolium pratense } Occasionally chief leguminous species.
Lathyrus pratense }
Leontodon hispidus } Vary much with season. Take turns
Plantago lanceolata } in being the most prominent miscel-
Centaurea nigra } laneous species.
Poterium sanguisorba }
Ranunculus spp. }
Carex præcox.
Conopodium denudatum.
Rumex acetosa.
Achillea millefolium.

* In Tables throughout the book—

G = *Graminaceæ*. L = *Leguminosæ*. M = *Miscellaneous species*.

OTHER SPECIES :—

Alopecurus, *Arrhenatherum*, *Avena flavescens*, *Cynosurus*, *Lolium*, *Poa pratensis*; *Trifolium repens*; *Agrimonia*, *Ajuga*, *Cerastium*, *Chrysanthemum*, *Galium*, *Hieracium*, *Luzula*, *Pimpinella*, *Potentilla reptans*, *Primula*, *Prunella*, *Scabiosa*, *Stellaria*, *Taraxacum*, *Thymus*, *Tragopogon*, *Veronica*.

N.B.—A species may almost disappear in one season, only to reappear in relatively large amount in later years.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. *Reduction in yield*, due to the long-continued robbing of the soil by removal of hay without any return as manure.

B. *Reduction in number of species*.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	18	15	17	17	13	13	12
L. .	4	4	4	4	4	4	3
M. .	28	24	28	31	26	23	14
	50	43	49	52	43	40	29

N.B.—There is a very considerable variation in the number that occur from year to year, probably owing to the great influence of season where a large number of species are living in association under conditions of soil exhaustion. Traces of those species that are reduced to the point of disappearance are still found on the plots, and occasionally a leaf or two appears in the samples.

C. *Changes in the personnel of the herbage*.—

Graminaceæ.—Reduced.

Poa trivialis. Disappeared.

Dactylis glomerata. Increased.

Lolium perenne. Reduced, practically disappeared.

Leguminosæ.—Practically no change, unless there is a certain reduction in quantity.

Miscellaneous.—Increased.

Poterium sanguisorba. Increased.

Centaurea nigra. Increased.

Leontodon hispidus. Increased.

} Have caused the greater
part of increase in
total.

Plantago lanceolata. Always variable. Probably little real change in quantity.

Luzula campestris. Decreased.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. . .	70·61	65·53	68·66	71·15	52·23	54·32	47·36
L. . .	8·10	5·35	8·98	8·54	7·77	5·78	4·51
M. . .	21·29	29·12	22·36	20·31	40·00	35·58	47·54

Change in Percentage of Certain Species as shown by Complete Separations.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Lolium perenne</i> .	6·37	4·03	2·37	4·55	—	0·06	—	—
<i>Poa trivialis</i> .	1·54	1·17	0·50	0·56	0·01	—	—	—
<i>Dactylis glomerata</i> .	1·76	1·74	0·90	0·70	1·05	3·65	8·34	+
<i>Luzula campestris</i> .	1·91	3·61	3·42	1·77	0·49	0·39	0·15	—
<i>Leontodon hispidus</i> .	0·06	0·64	1·27	1·32	5·98	17·06	6·87	+
<i>Centaurea nigra</i> .	0·31	0·59	2·11	1·06	4·05	8·70	5·69	+
<i>Plantago lanceolata</i> .	7·34	10·73	2·66	3·16	1·98	3·25	18·93	+(?)
<i>Poterium sanguisorba</i>	—	0·21	0·49	0·88	13·81	1·74	5·69	+

Among the miscellaneous plants very considerable variations occur in the quantity of the main species from year to year, and it is difficult to make a fair estimate of any true increase or decrease. The species in the above table seem, however, to show a definite trend, but most of the others show no clear tendency to change.

Effect of Liming.

A. On herbage and yield.—Limed half is not sharply differentiated from unlimed portion. The herbage is of similar character and appearance, and growth begins at much the same time in the spring.

A considerable increase of crop occurred till 1910, but since then the liming has apparently ceased to affect the yield.

B. On number of species.—No constant effect.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Increased.

Miscellaneous. Reduced.

		Unlimed.	Limed.	Increase or Decrease Due to Liming.
		Per cent.	Per cent.	
<i>Avena pubescens</i> .	1914	3·82	13·88	+
	1919	4·12	19·10	+
<i>Briza media</i> . .	1914	4·10	10·26	+
	1919	1·95	8·89	+
<i>Avena flavescens</i> .	1914	0·56	1·02	+
	1919	0·88	2·76	+
<i>Poa pratensis</i> . .	1914	0·06	1·53	+
	1919	0·15	1·94	+
<i>Agrostis vulgaris</i> .	1914	12·52	2·86	—
	1919	8·34	1·53	—
<i>Anthoxanthum odoratum</i>	1914	2·69	1·02	—
	1919	6·97	3·06	—
<i>Lol'yrus pratensis</i> .	1914	0·45	2·66	+
	1919	0·88	1·23	+(?)
<i>Ranunculus spp.</i> .	1914	0·17	0·97	+(?)
	1919	0·39	2·55	+
<i>Rumex acetosa</i> .	1914	0·34	0·56	No effect
	1919	1·96	4·19	+
<i>Leontodon hispidus</i> .	1914	17·06	3·52	—
	1919	6·87	1·53	—
<i>Conopodium denudatum</i>	1914	0·45	0·10	—
	1919	4·61	0·61	—

The increase of *Rumex* with liming in 1919, if actual, is noteworthy, as the reverse is usually the case. Cf. Plot 2, p. 16.

2. WITHOUT MANURE SINCE 1855. (PLOT 12.)

Present Condition of Plot (Unlimed).

- (a) Herbage compares very closely with Plot 3, with minor differences in constitution.
- (b) Growth starts late in spring.
- (c) Yield is generally rather higher than Plot 3.
- (d) Apparently rather more *Graminaceæ* and less *Miscellaneous* plants than on Plot 3.

Main Constituents of Association on Plot 12.

Association closely resembles that of Plot 3, except that—

Arrhenatherum avenaceum is more plentiful.

Poterium sanguisorba is absent.

Ranunculus spp. are less plentiful.

OTHER SPECIES :—

Same as those on Plot 3, with the addition of traces of *Alchemilla vulgaris*, *Bellis*, *Hypochæris*, *Potentilla fragariastrum*, *Thymus*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. *Reduction in yield*, as on Plot 3.

B. *Reduction in number of species*, as on Plot 3, but here again it may be more or less a seasonal variation only.

C. *Changes in the personnel of the herbage*.—

Graminaceæ.—Less reduction than on plot 3.

Dactylis glomerata. Increased.

Arrhenatherum avenaceum. Possible increase.

Briza media. Probable increase.

Festuca pratensis. Drastically reduced ; disappeared.

Poa trivialis. Disappeared.

Cynosurus cristatus. Disappeared.

Lolium perenne. Reduced almost to disappearance.

Leguminosæ.—Practically no change.

Miscellaneous.—Less increase than on plot 3.

Leontodon hispidus. Increased.

Plantago lanceolata. Probably increased.

Conopodium denudatum.—Possible increase; very variable.

Luzula campestris. Decreased.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919
G. . .	72.44	59.02	63.70	68.33	69.30	81.84
L. . .	6.20	10.79	10.17	7.48	7.31	4.72
M. . .	21.36	30.19	26.13	24.19	23.39	13.44

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> .	2.82	3.19	1.90	2.64	4.39	14.25	+
<i>Arrhenatherum avenaceum</i>	0.78	0.67	1.84	0.76	1.07	4.34	+
<i>Briza media</i> . . .	1.37	1.66	4.22	3.72	10.09	2.17	+
<i>Festuca pratensis</i> . .	10.11	3.94	2.25	3.27	—	—	—
<i>Poa trivialis</i> . . .	2.68	1.93	0.91	0.80	0.06	—	—
<i>Cynosurus cristatus</i> .	0.49	0.43	0.96	0.44	0.03	—	—
<i>Lolium perenne</i> . . .	4.46	3.09	1.91	2.28	0.06	0.07	—
<i>Leontodon hispidus</i> .	0.11	0.10	0.13	0.07	6.39	2.58	+
<i>Plantago lanceolata</i> .	7.74	8.25	0.41	1.43	5.08	14.92	+
<i>Conopodium denudatum</i> .	1.58	5.42	2.17	2.84	0.44	10.45	+(?)
<i>Luzula campestris</i> . .	1.14	2.96	2.98	1.50	0.44	0.27	—

3. UNMANURED SINCE 1864, AFTER FARMYARD MANURE, 1856-1863. (PLOT 2.)

Present Condition of Plot (Unlimed).

Closely resembles plot 3, but yield is consistently higher.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield, as on plot 3.

B. Reduction in number of species.—

Number of Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	14	17	18	18	13	13
L. . .	3	4	4	4	4	3
M. . .	13	20	25	28	18	16
Total .	30	41	47	50	35	32

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced.

Briza media. Increased.

Lolium perenne. Reduced.

Agrostis vulgaris. Reduced.

Avena flavescens. Probably reduced.

Poa trivialis. Disappeared.

Bromus mollis. Disappeared.

Leguminosæ.

Lotus corniculatus. Increased.

Lathyrus pratensis. Decreased.

Miscellaneous. Increased.

Plantago lanceolata. Increased, sometimes considerably.

Leontodon hispidus. Large increase in some years.

Centaurea nigra. Increased.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	75.05	84.52	80.02	75.42	60.46	57.94
L. . .	1.92	1.63	4.93	6.54	5.66	4.38
M. . .	23.03	13.85	15.05	18.04	33.88	37.68

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Briza media</i> . .	—	0.02	0.17	0.65	5.42	3.39	+
<i>Lolium perenne</i> . .	1.43	3.63	3.17	4.92	0.32	0.53	—
<i>Agrostis vulgaris</i> . .	2.64	4.94	11.02	17.97	7.94	8.42	—
<i>Avena flavescens</i> . .	6.02	5.88	11.62	2.92	0.97	1.17	—
<i>Poa trivialis</i> . .	28.18	15.75	3.07	2.37	—	—	—
<i>Bromus mollis</i> . .	17.77	16.39	3.89	0.18	—	—	—(?)
<i>Lotus corniculatus</i> . .	—	0.10	0.17	0.17	3.68	2.69	+
<i>Lathyrus pratensis</i> . .	0.98	1.17	3.96	5.25	0.71	0.82	—
<i>Leontodon hispidus</i> . .	—	0.02	0.02	0.04	16.01	2.75	+
<i>Plantago lanceolata</i> . .	1.67	3.08	1.45	3.70	5.29	20.34	+
<i>Centaurea nigra</i> . .	0.04	0.14	1.28	0.90	7.10	4.80	+

Effect of Liming.

A. On herbage and yield.—For herbage, cf. plot 3.

A considerable increase of crop occurred till 1910, but for several years afterwards liming depressed the yield. Apparently lime has little effect at the present time.

B. On number of species.—No constant effect.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Increased.

Miscellaneous. Reduced.

The increase of *Rumex* with liming in 1919, if actual, is noteworthy, as the reverse is usually the case.

			Unlimed.	Limed.	Increase or Decrease Due to Liming.
			Per cent.	Per cent.	
<i>Avena pubescens</i>	{	1914	4.71	17.64	+
		1919	4.68	20.16	+
<i>Poa pratensis</i>	{	1914	0.45	1.38	+
		1919	0.53	1.79	+
<i>Dactylis glomerata</i>	{	1914	3.68	4.73	+
		1919	10.53	15.01	+
<i>Avena flavescens</i>	{	1914	0.97	1.62	+
		1919	1.17	3.70	+
<i>Agrostis vulgaris</i>	{	1914	7.94	1.86	—
		1919	8.42	0.50	—
<i>Anthoxanthum odoratum</i>	{	1914	3.87	1.44	—
		1919	8.65	1.68	—
<i>Briza media</i>	{	1914	5.42	2.63	—
		1919	3.39	1.68	—
<i>Lathyrus pratensis</i>	{	1914	0.71	2.33	+
		1919	0.82	2.13	+
<i>Ranunculus spp.</i>	{	1914	0.26	1.32	+
		1919	0.53	4.37	+
<i>Rumex acetosa</i>	{	1914	0.45	0.42	No effect.
		1919	1.52	2.80	+(?)
<i>Leontodon hispidus</i>	{	1914	16.01	8.31	—
		1919	2.75	1.68	—
<i>Conopodium denudatum</i>	{	1914	0.52	0.12	—
		1919	4.33	0.67	—

4. UNMANURED AFTER AMMONIUM SALTS, 1856-1897. (PLOT 5¹)

Present Condition of Plot (Unlimed).

- (a) Herbage rather short and patchy in appearance ; clumps of *Dactylis* stand out clearly. Surface of area is springy, but less so than on plot 4².
- (b) Starts into growth late in spring.
- (c) Yield low, often below that of wholly unmanured plot 3
- (d) About thirty species.
- (e) *Graminaceæ* form bulk of herbage.
Leguminosæ barely represented.

Miscellaneous plants in good proportion, from 12-25 per cent. The large number of species present in very small quantity is striking.

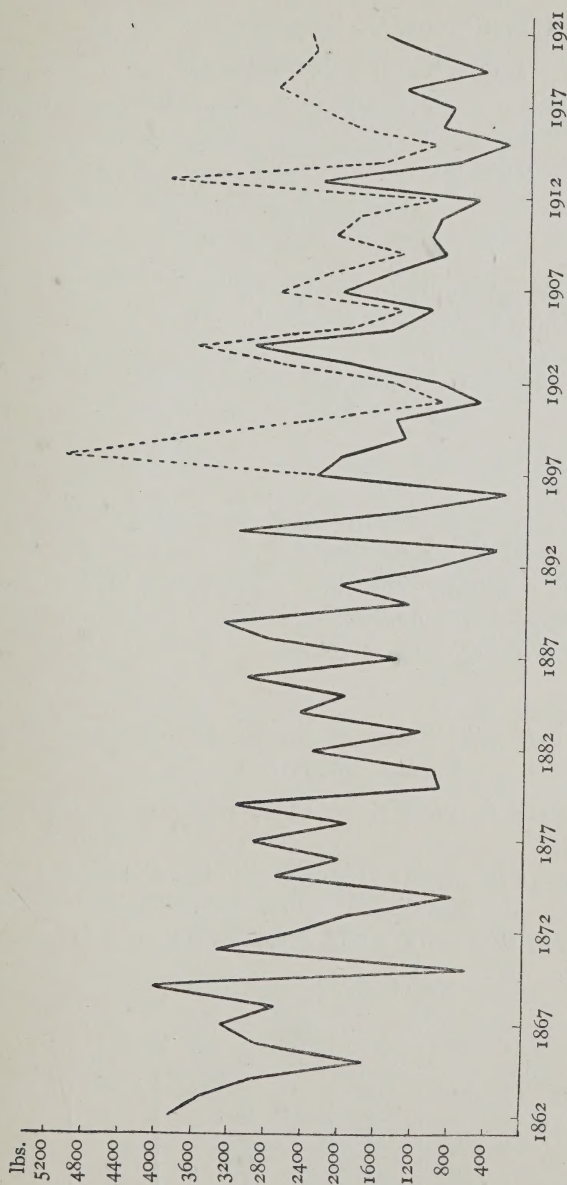


FIG. 2.—Curves showing Total Produce in lbs. per acre on Plot 5, with the alteration caused by the change of manuring in 1897. (First crop.)

- 1862-1897. Ammonium salts (Plot 5).
- 1898-1921. Unmanured (Plot 5¹).
- - - 1898-1921. Minerals (Plot 5²).

Main Constituents of Herbage on Plot 5¹.

Festuca ovina. Forms about half total crop.

Agrostis vulgaris.

Dactylis glomerata

Anthoxanthum odoratum

Poa pratensis

Arrhenatherum avenaceum

} Plentiful; order of prevalence
varies with season.

} In small amount.

Centaurea nigra. Usually in fair quantity.

Rumex acetosa. Occasionally plentiful.

Scabiosa arvensis

Conopodium denudatum

Galium verum

} Variable.

OTHER SPECIES:—

Aira, *Alopecurus*, *Avena flavescens*, *Av. pubescens*, *Bromus*, *Holcus*, *Poa trivialis*; *Lathyrus*, *Lotus*, *Trifolium pratense*, *Tri. repens*; *Achillea*, *Cerastium*, *Conopodium*, *Heracleum*, *Hieracium*, *Hypochaeris*, *Leontodon*, *Luzula*, *Pimpinella*, *Plantago*, *Ranunculus*, *Stellaria*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield since 1898, when manuring was discontinued.

B. Reduction in number of species till after the application of ammonium salts was discontinued, since when an increase has occurred in *Leguminosæ* and *Miscellaneous* plants.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	17	15	15	13	13	11	10
L. .	4	4	3	2	0	3	1
M. .	17	17	13	14	8	17	14
Total .	38	36	31	29	21	31	25

C. Changes in the personnel of the herbage:—

Graminaceæ. Increased.

Anthoxanthum odoratum. Increased.*Dactylis glomerata*. Increased since change in manuring.*Agrostis vulgaris*. Decreased ; very variable.*Holcus lanatus*. Decreased.*Lolium perenne*. Disappeared.

Leguminosæ. Practically no change.

Miscellaneous. Increased.

Centaurea nigra. Increased since change in manuring.*Rumex acetosa*. Very variable. Possibly increasing, or may have increased previous to cessation of manuring, and now be decreasing again.*Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.*

	182.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	86.32	71.85	84.70	94.06	82.38	86.39	77.81
L. .	0.12	0.34	0.46	0.19	—	0.46	0.39
M. .	13.56	27.81	14.84	5.75	17.62	13.15	21.80

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Anthoxanthum odoratum</i> .	5.77	5.51	3.04	4.09	12.29	8.18	11.62	+
<i>Dactylis glomerata</i> .	2.39	1.39	0.70	3.25	1.32	9.18	8.82	+
<i>Agrostis vulgaris</i> .	24.30	20.97	26.62	29.46	11.65	17.03	4.46	—
<i>Holcus lanatus</i> .	10.08	5.15	1.90	3.01	0.03	0.22	0.57	—
<i>Lolium perenne</i> .	3.33	1.21	0.97	0.09	—	—	—	—
<i>Centaurea nigra</i> .	0.01	2.43	2.18	0.53	0.71	6.96	3.84	+
<i>Rumex acetosa</i> .	9.15	15.94	7.13	2.13	14.84	1.34	12.24	?

B. MINERAL MANURES. (TABLES III. AND IV.)

5. MIXED MINERAL MANURE. (PLOT 7.)

Present Condition of Plot (Unlimed).

(a) Herbage is very varied and well developed, with thick bottom grass and some amount of top growth of flowering grasses. Colour is good, sometimes rather light.

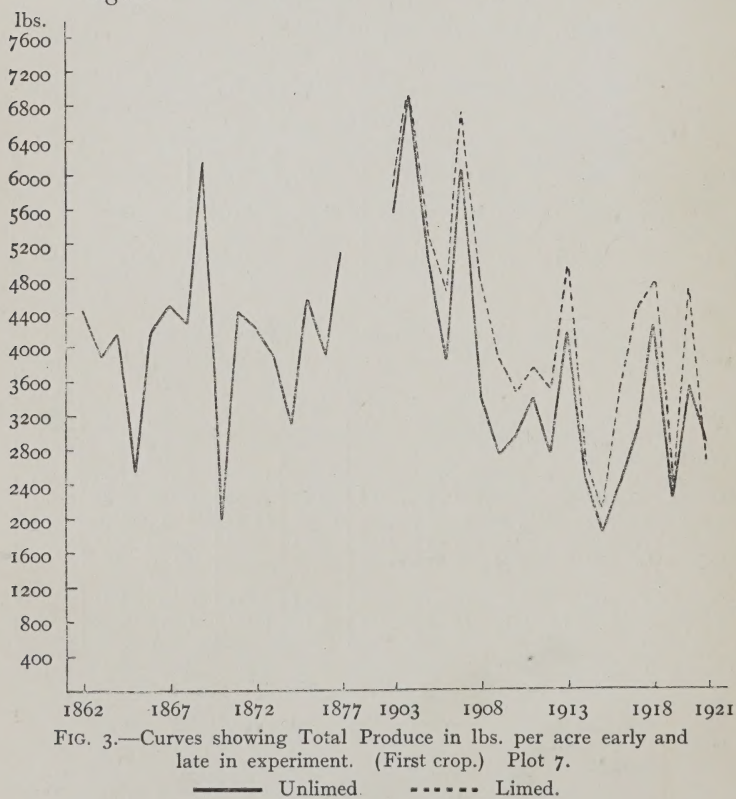


FIG. 3.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 7.

— Unlimed. Limed.

- (b) Growth starts fairly late in spring.
 (c) Yield good ; less seasonal variation than on plots receiving nitrogen.
 (d) Twenty-five to forty species (much influenced by season).
 (e) The three main groups of plants are all well represented, the proportions being very variable, though *Leguminosæ* are always plentiful. The range as shown by the partial separations from 1903-1919 was :—

	Lowest per cent.	Highest per cent.
G. . .	41·75 (1903).	74·84 (1916).
L. . .	8·73 (1919).	33·15 (1903).
M. . .	10·02 (1916).	38·99 (1919).

Main Constituents of Association on Plot 7.

Festuca ovina
Dactylis glomerata } Most abundant *Graminaceæ*.

Agrostis vulgaris
Anthoxanthum odoratum } Present in fair quantity.
Holcus lanatus

Bromus mollis
Avena pubescens } Occasionally rather conspicuous ;
Arrhenatherum avenaceum } at other times insignificant.

Lathyrus pratensis. Chief leguminous species.
Trifolium pratense.

Centaurea nigra
Achillea millefolium } Vary in relative amount from year
Rumex acetosa } to year.
Conopodium denudatum
Heracleum sphondylium

OTHER SPECIES :—

Alopecurus, *Avena flavescens*, *Briza*, *Festuca pratensis*,
Lolium, *Poa pratensis*, *P. trivialis* ; *Lotus*, *Trifolium repens*,

Vicia sepium ; *Carex*, *Cerastium*, *Galium*, *Leontodon*, *Luzula*, *Pimpinella*, *Plantago*, *Primula*, *Ranunculus* spp., *Scabiosa*, *Spiræa*, *Stellaria*, *Tragopogon*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Yields have remained constant except for seasonal fluctuations, with a period of high yields from 1902-1907.

B. Reduction in number of species in *Graminaceæ* and *Miscellaneous* plants.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	18	16	17	17	16	14	12
L. .	4	4	4	4	4	5	5
M. .	20	22	20	22	17	14	15
Total .	42	42	41	43	37	33	32

C. Changes in the personnel of the herbage.—

The relative proportions of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous* species have not undergone any permanent change, but the seasonal fluctuations are very considerable, and in consequence the balance of the three groups is very variable from year to year.

Graminaceæ.

Dactylis glomerata. Increased.

Avena flavescens. Possibly reduced.

Poa trivialis. Reduced.

Cynosurus cristatus. Disappeared.

Lolium perenne. Practically disappeared.

Miscellaneous.

Centaurea nigra. Increased.

Heracleum sphondylium. Increased in some seasons.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	64·65	59·29	48·82	74·38	41·74	68·35	52·05
L. .	24·70	12·69	39·77	13·71	33·14	16·96	8·77
M. .	10·65	28·02	11·41	11·91	25·12	14·69	39·18

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> .	2·57	4·67	1·68	3·67	4·97	10·17	21·52	+
<i>Avena flavescens</i> .	4·02	4·84	3·72	3·65	6·64	1·84	0·71	—
<i>Poa trivialis</i> .	3·81	4·38	2·30	2·11	1·00	0·53	0·36	—
<i>Cynosurus cristatus</i>	0·08	0·22	0·09	0·10	0·05	—	—	—
<i>Lolium perenne</i> .	3·12	2·40	0·59	3·02	0·11	0·16	—	—
<i>Centaurea nigra</i> .	0·03	0·79	0·27	0·10	1·03	6·84	2·54	+
<i>Heracleum sphondylium</i>	—	0·21	0·02	0·57	1·87	0·53	4·16	+

Effect of Liming.

A. On herbage and yield.—Increase of *Alopecurus* and reduction of *Anthoxanthum* noticeable on inspection ; other-wise herbage is similar in character. In some years *Lathyrus* is specially encouraged. Yield improved.

B. On number of species.—No constant effect. Number may be either increased or decreased, according to season.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Increased.

Miscellaneous. Reduced.

Liming on this plot tends to reduce the quantity of most *Miscellaneous* plants, especially in seasons in which these make good growth on the unlimed plots.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i>	{ 1914	1·69	9·74	+
	1919	1·73	15·20	+
<i>Bromus mollis</i>	{ 1914	2·11	15·48	+
	1919	0·05	0·60	+
<i>Avena pubescens</i>	{ 1914	2·58	4·45	+
	1919	2·84	8·81	+
<i>Avena flavescens</i>	{ 1914	1·84	3·94	+
	1919	0·71	0·96	+
<i>Poa trivialis</i>	{ 1914	0·53	1·85	+
	1919	0·36	1·21	+
<i>Festuca ovina</i>	{ 1914	31·44	13·19	—
	1919	7·11	5·39	—
<i>Agrostis vulgaris</i>	{ 1914	7·00	4·25	—
	1919	5·38	2·01	—
<i>Anthoxanthum odoratum</i>	{ 1914	4·21	0·56	—
	1919	3·55	0·45	—
<i>Lathyrus pratensis</i>	{ 1914	10·64	15·80	+
	1919	7·11	19·53	+
<i>Trifolium pratense</i>	{ 1914	4·69	2·73	—
	1919	1·02	0·03	—
<i>Centaurea nigra</i>	{ 1914	6·84	3·49	—
	1919	2·54	1·11	—
<i>Achillea millefolium</i>	{ 1914	2·53	0·68	—
	1919	6·30	0·96	—
<i>Conopodium denudatum</i>	{ 1914	0·79	0·28	—
	1919	9·44	3·67	—
<i>Heracleum sphondylium</i>	{ 1914	0·53	0·32	—
	1919	4·16	1·56	—
<i>Plantago lanceolata</i>	{ 1914	0·74	0·20	—
	1919	1·32	0·50	—

6. MINERAL MANURE WITHOUT POTASH. (PLOT 8.)

Present Condition of Plot (Unlimed).

- (a) Herbage shorter and less luxuriant than in presence of potash; very varied, with much bottom grass; growth patchy; colour usually rather pale.
- (b) Starts into growth later than plot 7.
- (c) Yield rather low; much below that of plot 7.
- (d) Twenty-nine to forty-five species, according to season.

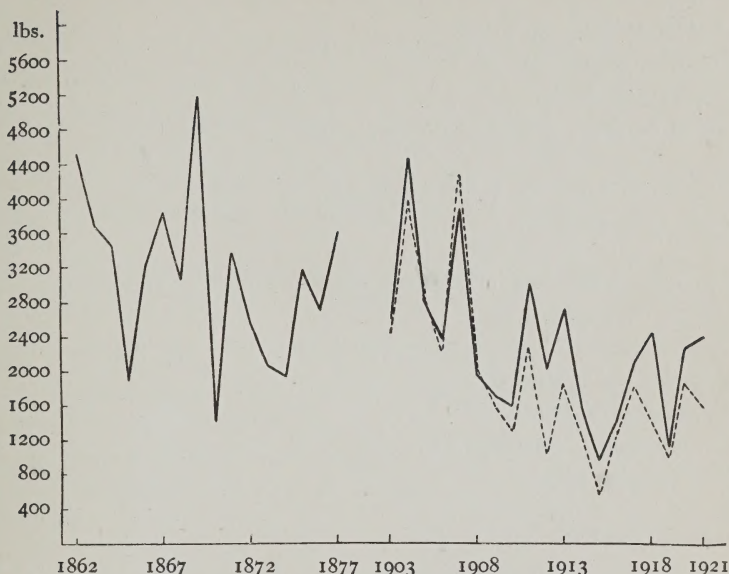


FIG. 4.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 8.

— Unlimed. - - - - - Limed.

- (e) The three main groups of plants are all well represented, with a large proportion of *Leguminosæ*. The range of percentage distribution as shown by the partial separations from 1903-1919, was—

	Lowest per cent.	Highest per cent.
G. .	30·14 (1912).	69·00 (1916).
L. .	2·69 (1917).	20·30 (1908).
M. .	22·73 (1916).	64·82 (1912).

Main Constituents of Association on Plot 8.

Festuca ovina } Usually among the three most abundant
Holcus lanatus } *Graminaceæ*.

Agrostis vulgaris
Arrhenatherum avenaceum } Occasionally among the three
Avena pubescens } most abundant *Graminaceæ*.

Anthoxanthum odoratum.

Dactylis glomerata.

Avena flavescens.

Briza media. Small in amount, but characteristic.

Trifolium pratense } Chief Leguminosæ.
Lathyrus pratensis }

Plantago lanceolata. Possibly chief Miscellaneous species.

Centaurea nigra

Rumex acetosa

Achillea millefolium

Leontodon hispidus.

Conopodium denudatum.

Ranunculus spp.

} Among most abundant species.

OTHER SPECIES :—

Alopecurus, *Bromus*, *Cynosurus*, *Lolium*, *Poa pratensis*,
P. trivialis ; *Lotus*, *Trifolium repens* ; *Agrimonia*, *Ajuga*,
Carex, *Cerastium*, *Galium*, *Heracleum*, *Luzula*, *Pimpinella*,
Primula, *Prunella*, *Scabiosa*, *Spiræa*, *Stellaria*, *Taraxacum*,
Tragopogon, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield, which began in 1880.

B. Reduction in number of species, chiefly during the last ten years.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	17	17	17	16	15	15	13
L. .	4	4	4	4	4	4	4
M. .	17	21	19	26	23	16	15
Total .	38	42	40	46	42	35	32

*C. Changes in the personnel of the herbage.—**Graminaceæ.* Reduced.*Poa trivialis.* Reduced.*Lolium perenne.* Much reduced.*Cynosurus cristatus.* Disappeared.*Festuca pratensis.* Disappeared.*Leguminosæ.* Increased.*Trifolium pratense.* Increased.*Miscellaneous.* Increased.*Plantago lanceolata.* Greatly increased.*Centaurea nigra.* Increased.*Rumex acetosa.* Very variable.*Leontodon hispidus.* Has come in.*Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.*

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	71·69	63·03	71·56	81·19	43·50	63·28	46·62
L. .	19·32	8·88	7·97	4·01	18·57	10·74	10·55
M. .	8·99	28·09	20·47	14·80	37·93	25·98	42·82

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Poa trivialis</i> . .	5·48	3·48	1·62	3·20	0·10	0·21	0·58	—
<i>Lolium perenne</i> . .	5·92	2·61	1·92	7·63	0·12	0·41	0·29	—
<i>Cynosurus cristatus</i> . .	0·25	0·24	1·02	1·14	0·46	0·07	—	—
<i>Festuca pratensis</i> . .	2·21	0·42	0·33	0·54	0·11	—	—	—
<i>Trifolium pratense</i> . .	7·71	1·13	0·27	0·36	1·38	5·36	4·91	+
<i>Plantago lanceolata</i> . .	0·71	1·53	0·34	0·26	5·85	8·66	18·25	+
<i>Centaurea nigra</i> . .	0·22	0·45	0·24	0·76	7·21	9·21	4·75	+
<i>Rumex acetosa</i> . .	1·93	7·86	1·96	5·84	1·91	0·55	6·83	(?)
<i>Leontodon hispidus</i> . .	—	—	—	—	0·85	1·03	0·67	+

Effect of Liming.

A. On herbage and yield.—Herbage is often very similar to that on unlimed plot, but in some years certain species, as *Avena pubescens* and *Arrhenatherum*, are particularly encouraged and cause a marked distinction.

Yield not much affected for the first few years, but since 1909 a constant depression has occurred.

B. On number of species.—No constant effect; usually almost the same on limed and unlimed areas.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Reduced.

Miscellaneous. Reduced.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Avena pubescens</i>	{ 1914	5·16	9·17	+
	1919	3·33	11·93	+
<i>Briza media</i>	{ 1914	1·51	9·17	+
	1919	0·42	1·95	+
<i>Arrhenatherum avenaceum</i>	{ 1914	3·02	3·91	No effect
	1919	7·92	17·94	+
<i>Holcus lanatus</i>	{ 1914	7·90	6·67	—
	1919	11·00	5·16	—
<i>Agrostis vulgaris</i>	{ 1914	7·77	5·19	—
	1919	3·83	1·95	—
<i>Trifolium pratense</i>	{ 1914	5·36	4·87	— ?
	1919	4·92	1·52	—
<i>Scabiosa arvensis</i>	{ 1914	0·82	1·47	+
	1919	0·83	4·40	+
<i>Plantago lanceolata</i>	{ 1914	8·66	5·19	—
	1919	18·25	7·61	—
<i>Achillea millefolium</i>	{ 1914	2·75	1·22	—
	1919	4·75	2·03	—

The increase in the quantity of *Scabiosa* on the limed half of this plot is much more evident in the aftermath, when a large quantity usually runs up into flower.

Liming has no effect on *Arrhenatherum* in seasons unfavourable to growth, but causes much increase in good years.

7. MIXED MINERAL MANURE, AFTER AMMONIUM SALTS, 1856-1868. (PLOT 6.)

Present Condition of Plot (Unlimed).

Closely resembles plot 7, but proportion of *Leguminosæ* is usually higher.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Yields have apparently remained constant, except for seasonal fluctuations. It is, however, possible that a slight depression has set in during the last ten years, as several low yields have occurred during that period.

B. Number of species probably only affected by seasonal changes.

C. Changes in the personnel of the herbage.—

Graminaceæ. Decreased.

Alopecurus pratensis. Some increase.

Dactylis glomerata. Increased.

Avena pubescens. Increased.

Lolium perenne. Disappeared.

Leguminosæ. Greatly increased in some years.

Trifolium pratense. Probably increased.

Lathyrus pratensis. Increased.

Miscellaneous. Very variable.

Centaurea nigra. Increased.

Rumex acetosa. Very variable.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	80.52	62.66	79.23	79.96	35.62	63.10	57.17
L. .	0.28	0.10	1.58	6.68	40.83	24.44	11.46
M. .	19.20	37.24	19.19	13.36	23.55	12.46	31.37

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Alopecurus pratensis</i>	1.70	0.02	0.03	0.09	0.59	1.89	2.97	+
<i>Dactylis glomerata</i>	2.05	1.71	1.28	4.09	3.51	7.33	21.03	+
<i>Avena pubescens</i>	14.54	0.90	1.83	1.67	7.50	6.47	5.09	+
<i>Lolium perenne</i>	4.58	1.39	0.69	1.97	0.12	—	—	—
<i>Trifolium pratense</i>	0.03	0.01	0.04	0.08	5.91	5.11	0.42	+
<i>Lathyrus pratensis</i>	0.23	—	1.47	6.56	30.94	17.35	9.77	+
<i>Centaurea nigra</i>	—	1.40	1.41	0.44	1.35	6.07	1.80	+
<i>Rumex acetosa</i>	12.11	24.27	7.51	7.66	5.24	0.26	10.82	?

8. MIXED MINERAL MANURE SINCE 1876, AFTER NITRATE OF SODA, 1858-1875. (PLOT 15.)

Present Condition of Plot (Unlimed).

- (a) Herbage varied, compares with that on plot 7, but seasonal variations are not the same on the two plots; much bottom grass.
- (b) Rather later than plot 7 in starting into growth.
- (c) Yield medium, average rather below that of plot 7.
- (d) Twenty-five to thirty-five species.
- (e) Three groups well represented, but all are exceptionally variable. The range as shown by the partial separations from 1903-1919 was:—

	Lowest per cent.	Highest per cent.
G. .	37.80 (1907).	98.54 (1918).
L. .	— (1918).	49.90 (1907).
M. .	1.47 (1918).	36.54 (1912).

Main Constituents of Association on Plot 15.

<i>Festuca ovina</i>	} Vary with season in order of abundance.
<i>Agrostis vulgaris</i>	
<i>Dactylis glomerata</i>	
<i>Alopecurus pratensis</i>	
<i>Holcus lanatus</i>	

Anthoxanthum odoratum.

Bromus mollis.

Avena pubescens.

Arrhenatherum avenaceum.

Lathyrus pratensis. Often in very large amount.

Trifolium pratense } In small quantity.
Trifolium repens }

Achillea millefolium

Conopodium denudatum

Plantago lanceolata

Ranunculus spp.

Rumex acetosa

Taraxacum vulgare

} Vary in significance with season.

OTHER SPECIES:—

Avena flavescens, *Lolium*, *Poa pratensis*, *P. trivialis*; *Lotus*; *Ajuga*, *Anthriscus*, *Centaurea*, *Cerastium*, *Galium*, *Heracleum*, *Luzula*, *Pimpinella*, *Stellaria*, *Tragopogon*, *Veronica*.

Outline of Principal Changes During the Experimental Period, 1877-1919.

A. *Reduction in yield* after the change from nitrate of soda to minerals in 1876. This was followed by a period of high yields from 1897-1908, but since then a further depression has set in, though the yields tend to be higher than they were after 1876.

B. *Reduction in number of species*.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	17	16	17	15	16	13	12
L. .	4	4	3	4	5	4	2
M. .	18	19	19	24	15	12	11
Total .	39	39	39	43	36	29	25

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced.

Alopecurus pratensis. Increased.*Dactylis glomerata*. Increased.*Arrhenatherum avenaceum*. Has appeared to some extent.*Poa trivialis*. Much reduced.*Lolium perenne*. Much reduced, practically disappeared.*Briza media*. Disappeared.*Cynosurus cristatus*. Disappeared.

Leguminosæ. Heavy increase in some seasons.

Lathyrus pratensis. Greatly increased.*Trifolium repens*. Increased in some seasons; absent from samples in others.*Trifolium pratense*. Probably increased.

Miscellaneous. Decreased in some seasons.

Achillea millefolium. Increased.*Conopodium denudatum*. Variable. Sometimes increased.*Plantago lanceolata*. Variable. Sometimes increased.*Rumex acetosa*. Variable. Probably little change.

Several species have disappeared of which small quantities used to occur.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	78·26	80·02	78·76	83·45	50·05	59·45	69·25
L. .	0·27	0·51	0·12	1·80	28·97	33·11	5·39
M. .	21·47	19·47	21·12	14·75	20·95	7·44	25·35

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Alopecurus pratensis</i>	6.90	5.95	2.46	7.17	10.24	13.69	29.85	+
<i>Dactylis glomerata</i> .	2.09	0.21	0.11	0.36	0.48	2.41	4.93	+
<i>Arrhenatherum avena-</i> <i>ceum</i> . . .	0.04	—	—	—	0.16	0.52	1.45	+
<i>Poa trivialis</i> . . .	6.53	23.67	7.95	6.05	1.20	0.42	0.21	—
<i>Lolium perenne</i> . . .	7.49	3.24	4.42	7.32	0.02	0.16	—	—
<i>Briza media</i> . . .	0.05	0.02	0.20	0.30	0.22	—	—	—
<i>Cynosurus cristatus</i> .	0.07	0.03	0.01	0.13	—	—	—	—
<i>Lathyrus pratensis</i> .	—	0.04	—	1.47	16.29	27.65	5.27	+
<i>Trifolium repens</i> .	0.04	0.08	0.06	0.01	6.74	2.41	—	+(?)
„ <i>pratense</i> .	0.20	0.04	0.03	0.31	5.76	2.57	0.09	+(?)
<i>Achillea millefolium</i>	2.53	1.13	2.60	0.58	9.95	4.25	5.27	+
<i>Conopodium denudatum</i>	0.58	0.20	0.43	0.77	1.07	0.21	3.57	+(?)
<i>Plantago lanceolata</i> .	6.92	4.67	0.28	0.56	0.20	0.26	3.74	+(?)
<i>Rumex acetosa</i> .	6.64	7.34	2.06	5.79	1.56	0.21	7.31	?

9. SUPERPHOSPHATE AND SULPHATE OF POTASH AFTER AMMONIUM SALTS, 1856-1897. (PLOT 5².)

Present Condition of Plot (Unlimed).

- (a) Herbage very patchy and uneven, some grass being short, the rest tall. *Dactylis* clumps much in evidence at all seasons. Better growth than on plot 5¹.
- (b) Starts into growth late in spring.
- (c) Yield medium; considerably higher than plot 5¹. (Fig. 2.)
- (d) Twenty-five to thirty-five species with occasional traces of a few others.
- (e) Herbage well mixed, the relative proportions of the three groups being very variable, as is shown by the range from 1903-1919.

	Lowest per cent.	Highest per cent.
G. .	50.06 (1912).	88.70 (1904).
L. .	2.23 (1916).	15.80 (1908, 1912).
M. .	7.70 (1909).	34.16 (1912).

The large number of species present in very small quantity is even more striking than on plot 5¹.

Main Constituents of Association on Plot 5².

Festuca ovina. Chief Graminaceæ, abundant.

Agrostis vulgaris

Alopecurus pratensis

Anthoxanthum odoratum

Dactylis glomerata

Poa pratensis

Avena pubescens. Quantity small but constant.

} Well represented; vary in relative abundance.

Bromus mollis
Holcus lanatus
Arrhenatherum avenaceum

} Quantity small and variable.

Lotus corniculatus. Chief Leguminosæ.

Lathyrus pratensis.

Trifolium pratense. Fairly well represented in some seasons.

Rumex acetosa
Centaurea nigra

} Chief Miscellaneous plants; vary much with season.

Luzula campestris
Achillea millefolium

} Very noticeable in some years.

OTHER SPECIES:—

Avena flavescens, *Cynosurus*, *Lolium*, *Poa trivialis*; *Trifolium repens*, *Vicia sepium*; *Anthriscus*, *Bellis*, *Cerastium*, *Conopodium*, *Epilobium* sp., *Galium*, *Heracleum*, *Hieracium*, *Hypochaeris*, *Leontodon*, *Pimpinella*, *Plantago*, *Prunella*, *Ranunculus*, *Scabiosa*, *Stellaria*, *Taraxacum*, *Tragopogon*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield during the fifteen years following the change in manuring, but since 1912 the yields have shown a tendency to increase again. They are always higher than those on plot 5¹.

B. Reduction in number of species till after the application of ammonium salts was discontinued, since when an increase has occurred in Leguminosæ and Miscellaneous plants.

Number of Species.

	1862.	1867.	1872.	1877.	1904.*	1914.	1919.
G. .	17	15	15	13	?	11	11
L. .	4	4	3	2	?	4	3
M. .	17	17	13	14	?	17	17
Total .	38	36	31	29	25	32	31

* Figures for 1903 not available, and only aggregate figures recorded for 1904.

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced since change in manuring.

Alopecurus pratensis. Increased.*Poa pratensis*. Increased.*Bromus mollis*. Apparently reappeared.*Agrostis vulgaris*. Reduced.*Festuca ovina*. Reduced.*Lolium perenne*. Disappeared.

Leguminosæ. Considerably increased.

Lotus corniculatus. Increased.*Lathyrus pratensis*. Increased.

Miscellaneous. Increased since change in manuring.

Centaurea nigra. Increased since change.*Rumex acetosa*. Very variable.*Luzula campestris*. Increased since change ; very noticeable in spring.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1904.	1914.	1919.
G. .	86.32	71.85	84.70	94.06	88.70	76.26	63.19
L. .	0.12	0.34	0.46	0.19	3.20	8.45	4.54
M. .	13.56	27.81	14.84	5.75	8.10	15.29	32.27

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Alopecurus pratensis</i> .	0.65	0.47	0.83	0.23	3.96	11.11	+
<i>Poa pratensis</i> .	1.07	0.65	0.61	0.23	4.62	6.24	+
<i>Bromus mollis</i> .	—	—	—	—	2.97	0.06	+
<i>Agrostis vulgaris</i> .	24.30	20.97	26.62	29.46	16.54	8.39	—
<i>Festuca ovina</i> .	21.99	30.57	46.56	53.31	33.85	19.50	—
<i>Lolium perenne</i> .	3.33	1.21	0.97	0.09	—	—	— (?)
<i>Lotus corniculatus</i> .	0.05	0.31	0.41	0.14	3.79	3.06	+
<i>Lathyrus pratensis</i> .	0.02	0.01	0.04	0.05	1.98	1.25	+
<i>Centaurea nigra</i> .	0.01	2.43	2.18	0.53	8.85	3.40	+
<i>Rumex acetosa</i> .	9.15	15.94	7.13	2.13	2.47	18.03	?
<i>Luzula campestris</i> .	1.11	0.62	0.15	0.06	0.71	4.31	+

10. SUPERPHOSPHATE OF LIME. (PLOT 4¹.)

Present Condition of Plot (Unlimed).

- (a) Herbage resembles that of unmanured plots in spring, but later becomes rather more luxuriant.
 (b) Starts into growth rather late in spring.
 (c) Yield medium.

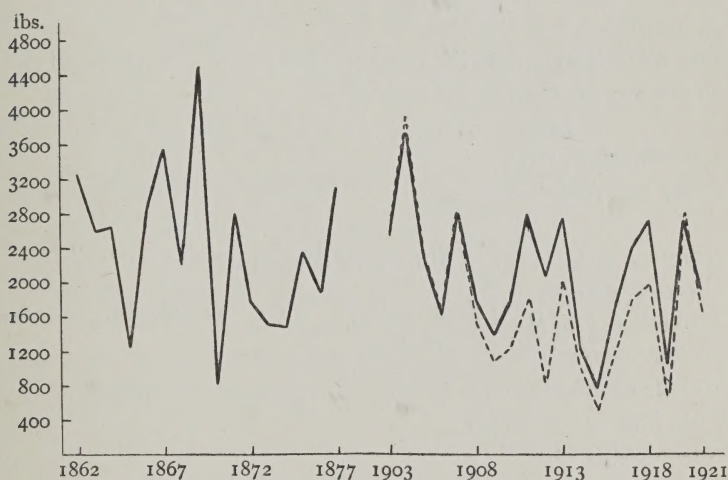


FIG. 5.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 4¹.

— Unlimed. - - - - - Limed.

- (d) Twenty-nine to forty-four species, subject to considerable seasonal fluctuations.
 (e) Three main groups of plants all well represented, the proportion being very variable. The range as shown by the partial separations from 1903-1919 was:—

	Lowest per cent.	Highest per cent.
G. .	32.46 (1912).	67.68 (1910).
L. .	2.62 (1910).	17.58 (1903).
M. .	28.39 (1916).	53.95 (1912).

Main Constituents of Association on Plot 4¹.

Avena pubescens }
Dactylis glomerata } Chief Graminaceæ ; vary in relative
Festuca ovina } abundance.
Holcus lanatus }
Anthoxanthum odoratum.

Avena flavescens.

Briza media.

Poa trivialis. Quantity small ; occasionally very scanty.

Trifolium pratense.

„ *repens*.

Lathyrus pratensis.

Lotus corniculatus.

Plantago lanceolata. Often very plentiful.

Centaurea nigra }
Leontodon hispidus } Vary much with season in relative
Rumex acetosa } amount.

Achillea millefolium.

Poterium sanguisorba.

Ranunculus spp.

OTHER SPECIES :—

Agrostis, *Alopecurus*, *Arrhenatherum*, *Avena flavescens*,
Bromus, *Cynosurus*, *Lolium*, *Poa pratensis* ; *Ononis* ; *Ajuga*,
Carex, *Cerastium*, *Conopodium*, *Luzula*, *Pimpinella*, *Prunella*,
Scabiosa, *Stellaria*, *Taraxacum*, *Tragopogon*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Yield has remained constant except for seasonal fluctuations.

B. Reduction in number of species, chiefly since 1903 ; the reduction may be largely seasonal.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	16	15	16	16	15	14	14
L. .	4	4	5	5	4	5	5
M. .	24	25	26	22	22	15	13
Total .	44	44	47	43	41	34	32

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced.

Dactylis glomerata. Increased.

Avena pubescens. Increased.

Lolium perenne. Reduced.

Poa trivialis. Reduced.

Agrostis vulgaris. Drastically reduced.

Alopecurus pratensis. Reduced almost to disappearance.

Leguminosæ. Show little change on the whole; very variable.

Miscellaneous. Increased.

Centaurea nigra. Increased.

Leontodon hispidus. Increased.

Plantago lanceolata. Probably increased.

Ranunculus spp. Reduced.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	74·96	66·88	67·03	71·78	43·00	57·67	52·77
L. .	2·79	2·83	8·61	5·53	17·58	7·69	2·76
M. .	22·25	30·29	24·36	22·69	39·42	34·64	44·47

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> .	2.25	0.99	0.57	1.41	1.30	4.60	11.29	+
<i>Avena pubescens</i> .	9.42	4.97	4.09	4.02	9.77	9.94	13.90	+
<i>Lolium perenne</i> .	9.28	5.24	3.12	4.35	0.02	0.12	0.22	—
<i>Poa trivialis</i> .	5.16	5.65	3.79	4.72	0.64	0.56	1.43	—
<i>Agrostis vulgaris</i> .	7.21	6.08	13.88	9.87	0.03	0.93	0.74	—
<i>Alopecurus pratensis</i>	1.32	1.84	0.86	1.40	0.31	0.06	0.09	—
<i>Centaurea nigra</i> .	0.43	0.36	1.01	0.66	4.77	8.64	7.51	+
<i>Leontodon hispidus</i> .	0.59	0.62	0.11	0.92	14.66	12.43	2.48	+
<i>Plantago lanceolata</i> .	5.63	9.66	3.13	3.78	2.49	6.77	17.80	+
<i>Ranunculus spp.</i> .	5.90	1.39	4.28	6.10	1.53	0.37	1.55	—

Effect of Liming.

A. On herbage and yield.—No apparent effect on herbage. Yield but little affected for the first few years, but since 1907 a marked depression has been evident.

B. On number of species.—No effect.

C. On personnel of herbage.—

Graminaceæ. Reduced or not affected.

Leguminosæ. Considerably increased.

Miscellaneous. Reduced.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Avena pubescens</i> .	{ 1914	9.94	12.67	+
	{ 1919	13.90	19.75	+
<i>Briza media</i> .	{ 1914	2.24	3.37	+
	{ 1919	1.30	2.84	+
<i>Alopecurus pratensis</i>	{ 1914	0.06	1.25	+
	{ 1919	0.09	1.48	+
<i>Dactylis glomerata</i> .	{ 1914	4.60	1.75	—
	{ 1919	11.29	6.36	—
<i>Holcus lanatus</i> .	{ 1914	8.64	6.37	—
	{ 1919	9.93	6.81	—
<i>Anthoxanthum odoratum</i>	{ 1914	3.98	1.50	—
	{ 1919	3.16	1.82	—
<i>Lathyrus pratensis</i> .	{ 1914	1.68	11.24	+
	{ 1919	1.61	5.00	+
<i>Lotus corniculatus</i> .	{ 1914	1.06	2.12	+
	{ 1919	0.74	3.63	+
<i>Ranunculus spp.</i> .	{ 1914	0.37	1.12	+
	{ 1919	1.55	4.54	+
<i>Leontodon hispidus</i> .	{ 1914	12.43	6.81	—
	{ 1919	2.48	2.27	No effect
<i>Plantago lanceolata</i> .	{ 1914	6.77	4.00	—
	{ 1919	17.80	11.24	—
<i>Rumex acetosa</i> .	{ 1914	0.68	0.62	No effect
	{ 1919	10.17	6.24	—

A noticeable feature on this plot is the large number of species that are considerably affected by liming, whether beneficially or adversely.

With *Leontodon* and *Rumex* the action of lime varies with season ; it has no effect in years unfavourable to the growth of these two species, but causes much reduction in good years.

C. NITRATE OF SODA WITH AND WITHOUT
MINERAL MANURES. (TABLE IV.)

11. NITRATE OF SODA. (PLOT 17.)

Present Condition of Plot (Unlimed).

- (a) Herbage very mixed, rather uneven, of a dark blackish green colour ; not so tall as on plot 16 ; many small bare patches. Not at all a good type of vegetation.
- (b) Starts into growth early in spring, but is slow in making headway.
- (c) Yield medium, usually less variable than on many other plots.
- (d) About thirty to thirty-five species, with occasional traces of several others.
- (e) *Graminaceæ* and *Miscellaneous* plants in nearly equal proportions in some seasons ; in others the latter are somewhat less plentiful.

Leguminosæ very scanty.

The large number of species present in very small quantity is striking.

Main Constituents of Association on Plot 17.

<i>Agrostis vulgaris</i>	}	Vary with season in relative abundance.
<i>Alopecurus pratensis</i>		
<i>Anthoxanthum odoratum</i>		
<i>Avena pubescens</i>		
<i>Dactylis glomerata</i>		
<i>Festuca ovina</i>	}	Usually in very small quantity ; occasionally rather more plentiful.
<i>Holcus lanatus</i>		
<i>Lolium perenne</i>		
<i>Briza media</i>		
<i>Avena flavescens</i>		

Plantago lanceolata. Very abundant.

Centaurea nigra
Leontodon hispidus } Plentiful.

Achillea millefolium.

Conopodium denudatum.

OTHER SPECIES :—

Arrhenatherum, *Bromus*, *Cynosurus*, *Poa pratensis*,
P. trivialis ; *Lathyrus*, *Lotus*, *Trifolium pratense*, *T. repens* ;
Ajuga, *Carex*, *Cerastium*, *Fritillaria*, *Galium*, *Luzula*,
Ophioglossum, *Pimpinella*, *Potentilla reptans*, *Prunella*,
Ranunculus, *Rumex*, *Spiræa*, *Stellaria*, *Taraxacum*,
Tragopogon, *Veronica*, *Viola*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield till about 1908, since when the yield has been remarkably steady, with comparatively small seasonal fluctuations. (N.B.—In 1920 an exceptionally heavy crop occurred.)

B. Probable reduction in number of species, though this may be chiefly due to seasonal variation.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	16	16	17	16	15	14	14
L. .	4	3	4	4	4	3	2
M. .	13	28	22	29	20	14	15
Total .	33	47	43	49	39	31	31

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced.

Dactylis glomerata. Increased.

Poa trivialis. Reduced.

Lolium perenne. Reduced.

Leguminosæ. Practically no change.

Miscellaneous. Increased.

Leontodon hispidus. Increased.

Plantago lanceolata. Increased.

Ranunculus spp. Reduced.

Rumex acetosa. Reduced.

Several species have disappeared of which small quantities used to occur.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	81.36	75.72	73.27	75.87	56.01	68.83	58.53
L. .	0.42	0.70	1.38	0.91	2.59	0.56	0.43
M. .	18.22	23.58	25.35	23.22	41.43	30.61	41.04

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> .	1.80	0.57	0.64	0.58	0.92	5.72	8.29	+
<i>Poa trivialis</i> .	5.21	12.08	2.74	1.59	0.96	0.07	0.54	—
<i>Lolium perenne</i> .	5.09	3.23	2.94	6.68	0.54	1.39	0.75	—
<i>Leontodon hispidus</i> .	0.02	0.05	0.07	0.25	3.68	4.39	3.34	+
<i>Plantago lanceolata</i> .	3.85	4.83	2.41	7.99	10.70	13.87	24.01	+
<i>Ranunculus spp.</i> .	2.09	1.33	2.48	4.91	3.92	0.63	0.81	—
<i>Rumex acetosa</i> .	3.57	7.53	1.58	2.56	1.80	0.35	0.86	—

**12. NITRATE OF SODA (275 LBS. PER ACRE)
AND MIXED MINERAL MANURE. (PLOT 16.)**

Present Condition of Plot (Unlimed).

- (a) Herbage tall and inclined to lodge, but with thick bottom grass. Fairly dark colour, occasional bare patches early in year.

- (b) Starts into growth fairly early.
 (c) Yield heavy, but below plot 14.

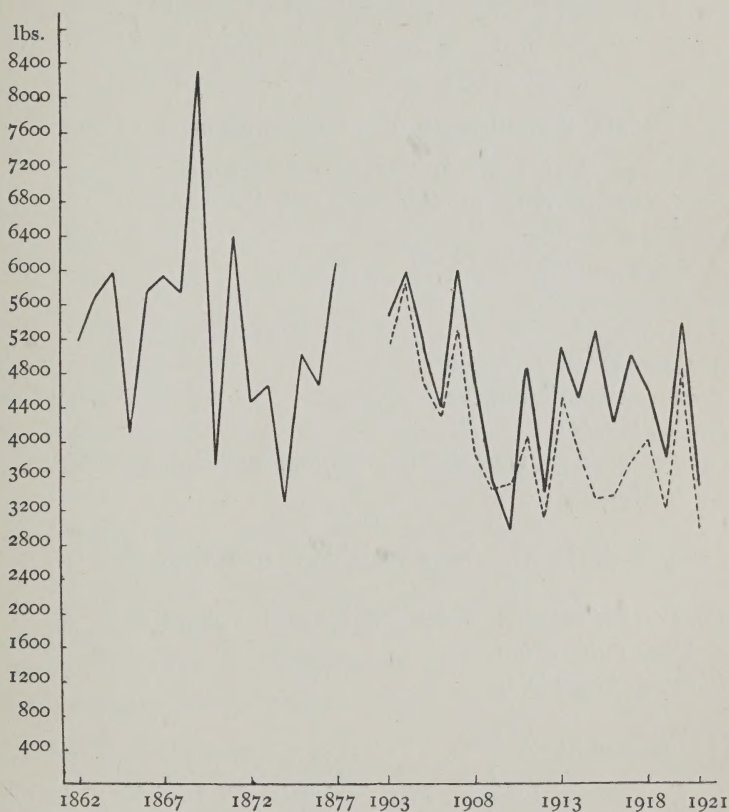


FIG. 6.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 16.

— Unlimed. - - - - - Limed.

- (d) About twenty-five species, with occasional traces of others.
 (e) Composition of herbage variable, as proportions of *Leguminosæ* and *Miscellaneous* species vary so much with season ; compare 1914 and 1919.

	1914.	1919.
G. . .	75.64	85.98
L. . .	15.89	1.17
M. . .	8.47	12.85

Main Constituents of Association on Plot 16.

Alopecurus pratensis. Most abundant species.

Dactylis glomerata. Occasionally very plentiful.

Festuca ovina.

Agrostis vulgaris.

Avena pubescens.

Avena flavescens.

Arrhenatherum avenaceum.

Anthoxanthum odoratum.

Holcus lanatus.

Bromus mollis. Occasionally prominent ; in some seasons negligible.

Lathyrus pratensis. Very variable in quantity.

Taraxacum vulgare. Occasionally rather plentiful.

Achillea millefolium.

Plantago lanceolata.

OTHER SPECIES :—

Cynosurus, *Lolium*, *Poa pratensis*, *P. trivialis* ; *Lotus*, *Trifolium pratense*, *Tri. repens* ; *Anthriscus*, *Carex*, *Centaurea*, *Conopodium*, *Luzula*, *Primula*, *Ranunculus*, *Rumex*, *Tragopogon*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. *Slight reduction in yield* soon after 1877, since when the yield has remained fairly constant, except for seasonal

fluctuations. These latter are now less marked than they were in the initial period 1862-1877.

B. *Reduction in number of species*, in all groups.

Number of Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G.	17	14	17	15	12	11
L.	3	4	4	4	3	1
M.	14	16	15	22	11	9
Total	34	34	36	41	26	21

C. *Changes in the personnel of the herbage.*—

Graminaceæ.

Alopecurus pratensis. Increased.

Arrhenatherum avenaceum. Increased.

Dactylis glomerata. Increased.

Agrostis vulgaris. Reduced.

Holcus lanatus. Reduced.

Poa trivialis. Reduced.

Festuca ovina. Reduced.

Avena flavescens. Reduced.

Lolium perenne. Disappeared.

Leguminosæ. Very variable.

Miscellaneous.

Taraxacum vulgare. Increased.

Plantago lanceolata. Increased.

Rumex acetosa. Possibly reduced.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G.	78.01	84.43	81.58	82.94	75.64	85.98
L.	2.24	1.79	7.45	9.40	15.89	1.17
M.	19.75	13.78	10.97	7.66	8.47	12.85

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Alopecurus pratensis</i> .	0·67	8·27	15·22	12·23	25·99	50·47	+
<i>Arrhenatherum avenaceum</i> .	0·12	—	0·17	0·08	2·72	3·25	+
<i>Dactylis glomerata</i> .	1·59	2·59	3·75	4·63	9·54	20·06	+
<i>Agrostis vulgaris</i> .	12·49	13·62	12·40	14·58	4·77	1·25	—
<i>Holcus lanatus</i> .	10·45	11·69	5·08	12·64	1·42	1·67	—
<i>Poa trivialis</i> .	6·87	8·96	6·53	4·82	0·11	0·25	—
<i>Festuca ovina</i> .	11·13	10·44	10·33	16·66	7·61	1·83	—
<i>Avena flavescens</i> .	18·37	14·86	18·80	6·67	3·58	1·17	—
<i>Lolium perenne</i> .	5·55	6·23	3·10	3·75	—	—	—
<i>Taraxacum vulgare</i> .	0·16	0·01	—	—	1·36	7·24	+
<i>Plantago lanceolata</i> .	1·25	0·84	0·07	0·22	2·84	2·50	+
<i>Rumex acetosa</i> .	5·46	5·62	1·19	2·19	0·11	1·00	— (?)

Effect of Liming.

A. On herbage and yield.—No marked difference caused by liming except perhaps a lessened tendency to lodge.

Yield depressed, occasionally to a considerable extent.

		Unlimed.	Limed.	Inc. or Dec. due to Liming.
		Per Cent.	Per Cent.	
<i>Festuca ovina</i> .	{	1914 7·61	30·57	+
		1919 1·83	11·34	+
<i>Avena pubescens</i> .	{	1914 5·00	13·84	+
		1919 2·75	17·64	+
<i>Poa trivialis</i> .	{	1914 0·11	1·56	+
		1919 0·25	0·42	+(?)
<i>Agrostis vulgaris</i> .	{	1914 4·77	0·14	—
		1919 1·25	0·24	—
<i>Anthoxanthum odoratum</i>	{	1914 2·84	0·14	—
		1919 2·00	0·03	—
<i>Holcus lanatus</i> .	{	1914 1·42	0·55	—
		1919 1·67	0·21	—
<i>Bromus mollis</i> .	{	1914 7·83	2·99	—
		1919 Trace	0·03	No effect
<i>Alopecurus pratensis</i>	{	1914 25·99	25·47	No effect
		1919 50·47	35·93	—
<i>Lathyrus pratensis</i> .	{	1914 14·41	1·33	—
		1919 1·17	0·72	—
<i>Plantago lanceolata</i> .	{	1914 2·84	0·41	—
		1919 2·50	1·50	—
<i>Taraxacum vulgare</i> .	{	1914 1·36	0·32	—
		1919 7·24	0·06	—

B. On number of species.—No constant effect.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Decreased.

Miscellaneous. Decreased.

This is the only plot on which liming causes decrease in *Alopecurus* in some seasons. The reason for this variation is not clear.

13. NITRATE OF SODA (550 LBS. PER ACRE) AND MIXED MINERAL MANURE. (PLOT 14.)

Present Condition of Plot (Unlimed).

- (a) Herbage dark green, very lush, and usually lodges badly. In the spring *Anthriscus sylvestris* and *Taraxacum vulgare* are very conspicuous, and in some seasons the leaves of the latter reach 2 feet in length. Occasional bare patches occur.
- (b) One of the earliest plots to start into growth in spring.
- (c) Yield heavy. Higher than that of plot 9, receiving an equal amount of nitrogen, but less than plots 11¹, 11², which have additional nitrogen.
- (d) Sixteen to twenty species, with occasional traces of a few others.
- (e) *Graminaceæ* form about 90 per cent. of the herbage.
Leguminosæ in small quantity, only represented by
Lathyrus pratensis.
Miscellaneous plants in small quantity.

Main Constituents of Association on Plot 14.

<i>Alopecurus pratensis</i>	} Form bulk of herbage.
<i>Arrhenatherum avenaceum</i>	
<i>Festuca ovina</i>	} A fairly constant small percentage.
<i>Dactylis glomerata</i>	
<i>Avena pubescens</i>	

Poa pratensis } Occasionally in fair quantity, otherwise not
Bromus mollis } very appreciable.

Lathyrus pratensis. Only Leguminous species.

Taraxacum vulgare } Percentage small, but species con-
Anthriscus sylvestris } spicuous.
Rumex acetosa }

OTHER SPECIES :—

Agrostis, *Anthoxanthum*, *Avena flavescens*, *Holcus*, *Lolium*,
Poa trivialis ; *Lotus* (negligible) ; *Achillea*, *Centaurea*, *Ceras-
tium*, *Conopodium*, *Luzula*, *Plantago*, *Ranunculus*, *Scabiosa*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. *Slight reduction of yield*, which set in towards the beginning of the period but has not become more marked of late years.

B. *Reduction in number of species*, chiefly since 1903.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	15	14	14	15	13	12	11
L. .	3	3	2	1	2	1	1
M. .	10	13	14	11	9	6	4
Total .	28	30	30	27	24	19	16

C. Changes in the personnel of the herbage.—

Graminaceæ.

Arrhenatherum avenaceum. Greatly increased.

Festuca ovina. Increased.

Alopecurus pratensis. Variable, probably increased.

Avena pubescens. Possibly increased.

„ *flavescens*. Probably reduced.

Bromus mollis. Probably reduced.

Poa trivialis. Reduced.

Lolium perenne. Reduced almost to disappearance.

Holcus lanatus. Disappeared. (Noteworthy, as so much used to be present.)

Leguminosæ. Increased.

Lathyrus pratensis. Increased.

Miscellaneous. Reduced.

Taraxacum vulgare. Increased.

Rumex acetosa. Variable; probably reduced.

Several species have disappeared of which small quantities used to occur.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	89.52	94.25	92.87	87.81	85.54	91.21	92.80
L. .	0.13	0.39	1.36	0.76	3.35	4.00	2.38
M. .	10.35	5.36	5.77	11.43	11.12	3.81	4.68

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Arrhenatherum avenaceum</i> .	3.14	—	—	0.32	17.28	40.47	23.34	+
<i>Festuca ovina</i> .	0.88	1.58	0.16	0.48	2.75	5.87	5.05	+
<i>Alopecurus pratensis</i> .	0.22	3.54	3.72	20.18	28.72	22.36	53.55	+
<i>Avena pubescens</i> .	0.90	0.92	0.19	0.47	2.32	3.57	3.66	+
„ <i>flavescens</i> .	4.88	7.12	5.67	2.93	0.31	1.86	0.73	—
<i>Bromus mollis</i> .	18.04	17.69	42.10	8.02	22.97	5.15	0.51	—
<i>Poa trivialis</i> .	1.45	1.05	2.57	4.01	0.95	1.27	1.02	—
<i>Lolium perenne</i> .	13.80	9.36	5.55	2.63	0.04	0.08	—	—
<i>Holcus lanatus</i> .	6.60	6.63	3.67	12.75	0.02	—	—	—
<i>Lathyrus pratensis</i>	0.11	0.37	1.35	0.76	3.34	4.00	2.38	+
<i>Taraxacum vulgare</i>	0.19	0.23	0.18	0.63	0.67	1.94	1.17	+
<i>Rumex acetosa</i> .	6.88	1.11	0.61	4.40	0.57	0.52	1.02	—

D. AMMONIUM SALTS WITH MIXED MINERAL
MANURE. (TABLE V.)

14. AMMONIUM SALTS (400 LBS. PER ACRE)
AND MIXED MINERAL MANURE. (PLOT 9.)

Present Condition of Plot (Unlimed).

- (a) Herbage luxuriant but uneven, with some bare patches, especially in early part of year; not very varied; colour dark green; comparatively little bottom grass; hay is often stemmy. The scarcity of miscellaneous and leguminous plants brings the plot into sharp contrast with the neighbouring plots 8, 7, 6.
- (b) Starts into growth early in spring.
- (c) Yield high, with large seasonal fluctuations.
- (d) About ten to twenty species.
- (e) *Graminaceæ* usually 80-90 per cent.
Leguminosæ absent.
Miscellaneous species usually 10-20 per cent.

Main Constituents of Association on Plot 9.

<i>Agrostis vulgaris</i>	} Relative proportions vary greatly with season.
<i>Anthoxanthum odoratum</i>	
<i>Arrhenatherum avenaceum</i>	
<i>Festuca ovina</i>	
<i>Holcus lanatus</i>	
<i>Dactylis glomerata</i> .	
<i>Rumex acetosa</i> .	The only significant <i>Miscellaneous</i> species.

OTHER SPECIES:—

Alopecurus, *Avena flavescens*, *Poa pratensis*, *Poa trivialis*; *Lotus corniculatus* (negligible); *Achillea*, *Centaurea*, *Conopodium*, *Pimpinella*, *Plantago*, *Potentilla reptans*.

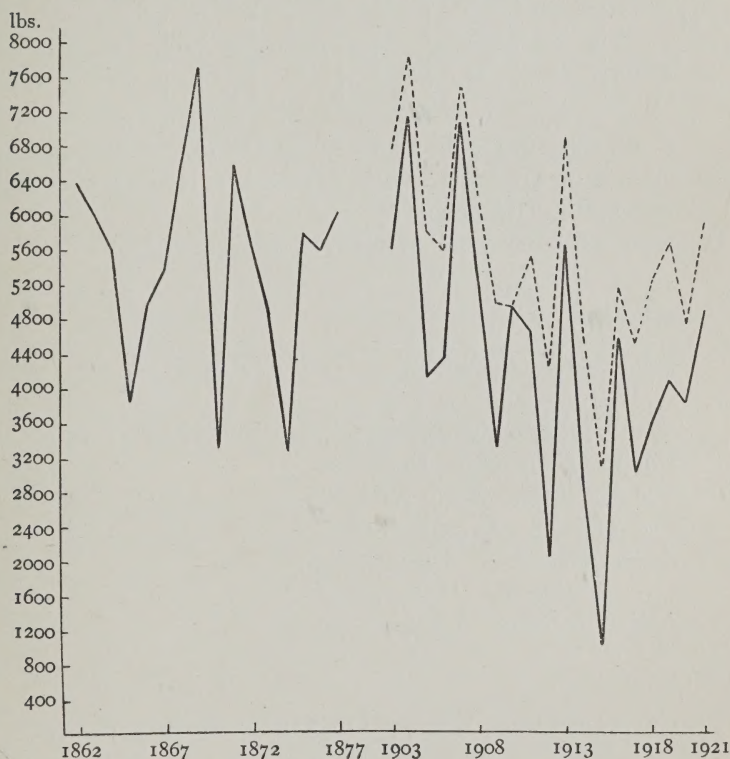


FIG. 7.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 9.

— Unlimed. - - - - - Limed.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Tendency towards reduction in yield; more very low yields in recent years than in early days of experiment.

B. Great reduction in number of species in all groups.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	13	14	16	13	12	9	8
L. .	2	2	1	4	1	—	—
M. .	13	13	13	10	7	5	3
Total ..	28	29	30	27	20	14	11

C. Changes in the personnel of the herbage.—Little change in balance of *Graminaceæ* and *Miscellaneous* species, except for seasonal fluctuations.

Leguminosæ have more completely disappeared.

Graminaceæ.

Anthoxanthum odoratum. Much increased, but very variable.

Arrhenatherum avenaceum. Increased, but very variable.

Dactylis glomerata. Reduced.

Poa pratensis. Much reduced.

Poa trivialis. Disappeared.

Avena flavescens. Disappeared.

„ *pubescens.* Disappeared.

Lolium perenne. Disappeared.

Miscellaneous.

Rumex acetosa. Increased in some seasons.

Percentage of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous Species.*

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	88.59	77.06	92.19	94.65	95.89	94.65	85.00
L. .	0.13	0.16	0.02	0.41	0.01	—	—
M. .	11.28	22.78	7.79	4.94	4.10	5.35	15.00

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Anthoxanthum odoratum</i> .	1.24	3.59	2.25	2.94	16.19	38.53	5.42	+
<i>Arrhenatherum avenaceum</i> .	—	2.50	11.40	13.23	43.30	8.49	46.75	+
<i>Dactylis glomerata</i>	5.58	4.64	11.88	14.07	5.14	5.04	3.29	—
<i>Poa pratensis</i> .	10.68	13.02	22.67	18.03	11.68	1.80	0.21	—
„ <i>trivialis</i> .	8.72	2.14	0.64	0.11	0.01	—	—	—(?)
<i>Avena flavescens</i> .	9.08	3.78	5.30	0.67	0.16	0.05	—	—
„ <i>pubescens</i> .	10.22	1.41	0.49	0.07	0.06	—	—	—
<i>Lolium perenne</i> .	4.20	1.01	1.11	0.16	—	—	—	—
<i>Rumex acetosa</i> .	5.40	10.89	4.60	3.60	2.79	4.37	14.82	+

Effect of Liming.

A. On herbage and yield.—Very great improvement. Growth very uniform, not patchy. Marked increase in *Alopecurus* and decrease in *Anthoxanthum*. The distinction between limed and unlimed halves is clearly marked throughout the growing season. Much inclined to lodge in most seasons.

Yield much increased.

B. On number of species.—No marked effect, but a tendency to increase.

		Unlimed.	Limed.	Increase or Decrease Due to Liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i> }	1914	1.65	17.65	+
	1919	0.67	25.94	+
<i>Poa pratensis</i> . }	1914	1.80	7.53	+
	1919	0.21	5.55	+
<i>Dactylis glomerata</i> . }	1914	5.04	6.86	+
	1919	3.29	6.82	+
<i>Arrhenatherum avenaceum</i> }	1914	8.49	38.57	+
	1919	46.75	47.20	No effect
<i>Agrostis vulgaris</i> . }	1914	18.16	2.69	—
	1919	12.42	2.26	—
<i>Anthoxanthum odoratum</i> }	1914	38.53	12.65	—
	1919	5.42	1.12	—
<i>Holcus lanatus</i> . }	1914	4.01	2.15	—
	1919	12.39	0.76	—
<i>Rumex acetosa</i> . }	1914	4.37	0.66	—
	1919	14.82	3.51	—

C. On personnel of herbage.—

Graminaceæ. Increased.*Leguminosæ*. Not affected.*Miscellaneous*. Reduced.

Almost every species of *Graminaceæ* occurring on this plot is much affected by liming. The varying response of *Arrhenatherum* in different seasons is very noticeable, as it is present in such large amount.

15. AMMONIUM SALTS (400 LBS. PER ACRE) AND MIXED MINERAL MANURE WITHOUT POTASH. (PLOT 10.)

Present Condition of Plot (Unlimed).

- (a) Herbage less luxuriant than on plot 9, but of similar type ; inclined to lodge.
- (b) Starts into growth early in spring.
- (c) Yield medium, much below that of plot 9.
- (d) About nine to seventeen species.
- (e) *Graminaceæ* usually 88-98 per cent.
Leguminosæ absent.
Miscellaneous usually 2-12 per cent.

Main Constituents of Association on Plot 10.

<i>Anthoxanthum odoratum</i>	} Vary in order of prevalence with season.
<i>Alopecurus pratensis</i>	
<i>Festuca ovina</i>	
<i>Arrhenatherum avenaceum</i>	
<i>Holcus lanatus</i> . Occasionally plentiful, otherwise scanty.	
<i>Agrostis vulgaris</i> .	

Rumex acetosa. The only significant miscellaneous species.

OTHER SPECIES :—

Aira, *Avena pubescens*, *Dactylis*, *Poa pratensis* ; *Lathyrus* (negligible) ; *Achillea*, *Centaurea*, *Cerastium*, *Plantago*, *Potentilla reptans*, *Ranunculus*, *Scabiosa*.

Outline of Principal Changes during the Experimental Period 1877-1919.

A. *Reduction in yield*, which has become more evident since 1909.

B. *Great reduction in number of species* in all groups.

Number of Species.

	1862.	1867.	1872.	1877	1914.	1919.
G. .	16	15	15	15	8	9
L. .	2	1	2	2	—	—
M. .	13	11	6	11	4	1
Total	31	27	23	28	12	10

C. *Changes in the personnel of the herbage*.—Balance of *Graminaceæ* and *Miscellaneous* species is unchanged, except for seasonal fluctuations.

Leguminosæ have disappeared more completely.

Graminaceæ.

Anthoxanthum odoratum. Heavy increase.

Arrhenatherum avenaceum. Probably increased ; very variable.

Alopecurus pratensis. Increase of 1877 maintained.

Agrostis vulgaris. Reduced.

Dactylis glomerata. Reduced.

Poa pratensis. Much reduced.

„ *trivialis*. Disappeared.

Avena pubescens. Disappeared.

„ *flavescens*. Disappeared.

Bromus mollis. Disappeared.

Lolium perenne. Disappeared.

Miscellaneous. Several species have now disappeared of which traces used to occur. *Rumex acetosa* is now the only constant representative ; very variable.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	85.45	82.63	94.68	93.42	98.66	92.60
L. . .	0.12	0.08	0.02	0.02	—	—
M. . .	14.43	17.29	5.30	6.56	1.34	7.40

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Anthoxanthum odoratum</i>	1.46	5.27	3.26	5.84	49.37	21.02	+
<i>Arrhenatherum avenaceum</i>	0.08	11.71	13.22	9.58	4.76	25.92	+
<i>Alopecurus pratensis</i> . .	2.05	2.99	10.35	16.51	18.59	20.77	+
<i>Agrostis vulgaris</i> . . .	9.37	8.61	14.17	16.29	2.95	4.01	—
<i>Dactylis glomerata</i> . .	12.51	5.44	3.12	4.88	1.00	1.57	—
<i>Poa pratensis</i>	4.06	14.81	19.62	6.48	0.86	0.31	—
„ <i>trivialis</i>	10.18	2.78	1.21	0.47	—	—	—
<i>Avena pubescens</i> . . .	10.64	1.64	0.44	0.24	—	—	—
„ <i>flavescens</i>	10.05	2.00	0.77	0.18	—	—	—
<i>Bromus mollis</i>	2.53	0.69	1.74	1.55	—	—	—
<i>Lolium perenne</i> . . .	3.02	1.84	0.57	0.17	—	—	—

Effect of Liming.

A. On herbage and yield.—Great improvement. Marked increase in *Alopecurus* and decrease in *Anthoxanthum*, as on plot 9. More inclined to lodge than where no lime is applied. The distinction between limed and unlimed areas is clearly marked throughout the growing season.

Yield much increased.

B. On number of species.—Usually a slight reduction.

C. On personnel of herbage.—

Graminaceæ. Increased.

Leguminosæ. Not affected.

Miscellaneous. Decreased.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i>	1914	18.59	46.45	+
	1919	20.77	76.83	+
<i>Poa pratensis</i> . . .	1914	0.86	4.30	+
	1919	0.31	5.97	+
<i>Anthoxanthum odoratum</i>	1914	49.37	15.18	—
	1919	21.02	1.08	—
<i>Festuca ovina</i> . . .	1914	19.02	14.77	—
	1919	6.87	5.20	—
<i>Agrostis vulgaris</i> .	1914	2.95	3.11	No effect
	1919	4.01	0.54	—
<i>Holcus lanatus</i> .	1914	1.05	1.51	+(?)
	1919	11.56	0.06	—
<i>Arrhenatherum avenaceum</i>	1914	4.76	9.19	+
	1919	25.92	8.13	—
<i>Rumex acetosa</i> .	1914	1.14	0.23	—
	1919	7.40	0.39	—

N.B.—The marked variation in response of *Arrhenatherum* to liming in different seasons.

Also, the marked decrease in *Agrostis* and *Holcus* in some seasons, and the absence of response in others.

16. AMMONIUM SALTS (600 LBS. PER ACRE) AND MIXED MINERAL MANURE. (PLOT 11¹.)

Present Condition of Plot (Unlimed).

- (a) Extremely patchy, especially in winter and spring. Herbage grows in large tufts interspersed with extensive bare spaces, which are covered with a kind of dry peat of partially decayed vegetable matter. In favourable seasons numerous seedlings of *Holcus* spring up on the bare patches, but comparatively few of these succeed in establishing themselves, as in the summer the heavy growth of the tufted vegetation overshadows the bare patches and helps to prevent the further growth of the seedlings thereon. There is practically no bottom grass; all the herbage runs

up to stem, and is very coarse and rank, with a tendency to lodge badly, so that it is generally necessary to cut the hay by scythe.

- (b) Is one of earliest plots to start into growth ; often vividly green in January and February, when most other plots are still brown and grey with dead grass.
- (c) Yield very heavy.
- (d) Eight species only are significant, with occasional traces of a few others.
- (e) *Graminaceæ* form practically all herbage.
Leguminosæ absent.
Miscellaneous plants in very small amount, rarely 2 per cent.

Main Constituents of Association on Plot 11¹.

Holcus lanatus. Dominant species.

Arrhenatherum avenaceum. Varies much with season, occasionally very plentiful ; sometimes present in small amount.

OTHER SPECIES :—

Agrostis, *Alopecurus*, *Anthoxanthum*, *Avena pubescens*, *Dactylis*, *Festuca*, *Poa pratensis* ; *Achillea*, *Plantago*, *Rumex*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield, most noticeable since 1904.

B. Reduction in number of species.

Number of Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. .	15	13	11	11	7	7
L. .	1	1	1	0	—	—
M. .	12	4	4	4	—	1
Total	28	18	16	15	7	8

*C. Changes in the personnel of the herbage.—**Graminaceæ.**Holcus lanatus.* Much increased.*Festuca ovina.* Reduced.*Alopecurus pratensis.* Reduced.*Agrostis vulgaris.* Much reduced.*Dactylis glomerata.* Very much reduced.*Poa pratensis.* Disappeared.,, *trivialis.* Disappeared.*Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.*

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	89.38	94.12	98.84	97.53	99.82	100.0	98.86
L. .	0.01	0.01	0.01	—	—	—	—
M. .	10.61	5.87	1.15	2.47	0.15	—	1.14

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Holcus lanatus</i> .	9.92	2.86	10.33	20.29	45.57	90.9	64.80	+
<i>Festuca ovina</i> .	1.46	0.50	0.38	4.15	0.02	0.12	0.08	—
<i>Alopecurus pra-</i> <i>tensis</i> .	2.80	13.11	12.35	9.91	25.51	1.15	0.77	—
<i>Agrostis vulgaris</i>	13.17	19.27	13.56	29.20	1.42	0.51	1.65	—
<i>Dactylis glomerata</i>	24.16	39.31	39.28	17.11	0.15	0.20	0.19	—
<i>Poa pratensis</i> .	9.43	12.86	10.40	1.47	0.17	—	—	—
,, <i>trivialis</i> .	13.25	0.14	0.09	0.33	—	—	—	—

Effect of Liming.

A. On herbage and yield.—Herbage is quite altered, and is very uniform, with none of the bare patches usually so characteristic of the unlimed end. The mass of *Holcus* is replaced by a mixture of *Alopecurus*, *Arrhenatherum*, and *Holcus*, which lodges badly. The contrast between limed and unlimed halves is greater here than on any other plot.

Yield much increased.

B. On number of species.—Increased.

	Unlimed.	Limed.
1914	7	10
1918	6	11
1919	8	10

C. On personnel of herbage.—

Balance of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous* species not affected.

		Unlimed.	Limed.	Increase or decrease due to liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i>	{	1914 1·15	27·22	+
		1919 0·77	63·91	+
<i>Dactylis glomerata</i>	{	1914 0·20	4·94	+
		1919 0·19	5·66	+
<i>Anthoxanthum odoratum</i>	{	1914 0·08	2·05	+
		1919 0·02	0·14	+
<i>Poa pratensis</i>	{	1914 —	2·71	+
		1919 —	1·95	+
<i>Holcus lanatus</i>	{	1914 90·90	31·95	—
		1919 64·80	11·63	—
<i>Arrhenatherum avenaceum</i>	{	1914 6·57	27·04	+
		1919 31·34	15·51	—

The great increase of *Alopecurus* and decrease of *Holcus*, due to liming, is very noticeable.

Arrhenatherum is the only prominent species which varies in its response to liming in different seasons.

17. AMMONIUM SALTS (600 LBS. PER ACRE) AND MIXED MINERAL MANURE WITH SILICATE OF SODA. (PLOT 11².)

Present Condition of Plot (Unlimed).

- (a) The bare patches so characteristic of plot 11¹ are not present here, owing to the ameliorating action of the silicate. The latter seems to have had much the same

effect as a dressing of lime, for at most seasons of the year the herbage resembles that on the limed half of plot 11¹.

(b) Starts into growth very early. Cf. plot 11¹.

(c) Yield is the heaviest obtained from the unlimed plots ; much less variable than in absence of silicate.

(d) Ten species only, with occasional traces of a few others.

(e) *Graminaceæ* form practically all herbage.

Leguminosæ absent.

Miscellaneous plants absent or in very small amount, rarely 1.5 per cent.

Main Constituents of Association on Plot 11².

Holcus lanatus
Alopecurus pratensis
Arrhenatherum avenaceum } Relative proportions vary with season.
Dactylis glomerata. Occasionally contributes about 2 per cent. ; insignificant in other seasons.

OTHER SPECIES:—

Agrostis, *Anthoxanthum*, *Avena pubescens*, *Cynosurus*, *Festuca*, *Poa pratensis*, *Poa trivialis* ; *Achillea*, *Centaurea*, *Conopodium*, *Heracleum*, *Plantago*, *Rumex*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Some reduction in yield, especially since 1904.

B. Reduction in number of species.

Number of Species.

	1862	1867.	1872.	1877.	1914	1919.
G. . .	14	14	13	11	8	9
L. . .	—	—	—	—	—	—
M. . .	7	5	3	5	—	1
Total .	21	19	16	16	8	10

C. Changes in the personnel of the herbage.—

Graminaceæ.

Holcus lanatus. Variable ; probably increased.*Arrhenatherum avenaceum*. Variable ; probably increased.*Poa pratensis*. Reduced.*Festuca ovina*. Possibly reduced.*Agrostis vulgaris*. Greatly reduced.*Dactylis glomerata*. Greatly reduced.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	94·24	95·67	99·26	98·46	100	99·63
L. . .	—	—	—	—	—	—
M. . .	5·76	4·33	0·74	1·54	—	0·37

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Holcus lanatus</i> . .	7·37	4·79	10·59	19·48	20·36	59·43	+
<i>Arrhenatherum avenaceum</i> . .	6·40	4·83	12·73	21·14	45·66	20·72	+(?)
<i>Poa pratensis</i> . .	5·12	10·38	12·43	4·50	0·11	0·68	—
<i>Festuca ovina</i> . .	0·66	2·05	0·30	2·55	0·06	0·04	—
<i>Agrostis vulgaris</i> . .	18·81	24·16	10·16	17·09	0·72	0·53	—
<i>Dactylis glomerata</i> . .	23·34	38·30	27·23	13·38	2·77	0·34	—

Effect of Liming.

A. On herbage and yield.—Herbage resembles plot 11¹ limed ; more uniform than on unlimed end, but contrast between the two is less marked than on plot 11¹. Lodges badly.

Yield usually increased, but difference is much less regular or marked than on plot 11¹. Occasionally yield is lower on limed area.

B. On number of species.—No constant effect.

C. On personnel of herbage.—

Balance of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous* species not affected.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i>	1914	17.54	49.26	+
	1919	29.78	76.02	+
<i>Dactylis glomerata</i> .	1914	0.34	10.86	+
	1919	2.77	7.31	+
<i>Poa pratensis</i> . .	1914	0.68	3.51	+
	1919	0.11	0.24	+(?)
<i>Holcus lanatus</i> .	1914	59.43	6.09	—
	1919	20.36	0.03	—
<i>Arrhenatherum avenaceum</i>	1914	20.72	25.39	+
	1919	45.66	16.34	—

The increase in *Alopecurus* and decrease in *Holcus* is very marked, though less so than on plot 11².

Arrhenatherum varies in its response to liming in the same way as on plot 11¹; obviously season plays a great part here.

E. AMMONIUM SALTS ALONE OR WITH INCOMPLETE MINERAL MANURES. (TABLE VI.)

18. AMMONIUM SALTS ALONE SINCE 1864
(ALSO FARMYARD DUNG, 1856-1863). (PLOT 1.)

Present Condition of Plot (Unlimed).

- (a) Previous to the application of ammonium salts in spring the herbage is backward in growth and very patchy, bare areas of soil often being present. Later in the season the grass becomes fairly long and very dark green, with a distinct tendency to lodge.
- (b) Starts into growth rather late in spring.
- (c) Yield usually low, but higher than on unmanured plots.
- (d) About sixteen species, with traces of several others.
- (e) *Graminaceæ* form bulk of herbage.
Leguminosæ absent.
Miscellaneous plants in fair quantity.

Main Constituents of Association on Plot 1.

<i>Festuca ovina</i>	}	Vary much in relative quantity.
<i>Agrostis vulgaris</i>		
<i>Anthoxanthum odoratum</i>		
<i>Holcus lanatus</i>		

Dactylis glomerata.

Alopecurus pratensis. Quantity small but constant.

<i>Centaurea nigra</i>	}	Quantity very variable; occasionally plentiful.
<i>Rumex acetosa</i>		

Conopodium denudatum.

OTHER SPECIES:—

Arrhenatherum, *Avena flavescens*, *Av. pubescens*, *Lolium*, *Poa pratensis*, *P. trivialis*; *Lathyrus* (negligible); *Achillea*, *Ajuga*, *Alchemilla*, *Cerastium*, *Galium*, *Luzula*, *Pimpinella*, *Plantago*, *Ranunculus*, *Spiræa*, *Stellaria*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Reduction in yield.

B. Reduction in number of species.—Very marked.

Number of Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	15	15	18	15	9	10
L. . .	4	4	3	2	—	—
M. . .	9	15	15	17	8	5
Total .	28	34	36	34	17	15

C. Changes in the personnel of the herbage.—

Graminaceæ. Proportion has remained fairly constant.

Dactylis glomerata. Possibly increased.

Festuca ovina. Increased, probably to a considerable extent.

Poa pratensis. Reduced.

„ *trivialis*. Reduction of 1872 continued practically to disappearance.

Avena pubescens. Probably reduced.

„ *flavescens*. Reduced almost to disappearance.

Bromus mollis. Disappeared.

Lolium perenne. Disappeared.

Leguminosæ. Disappeared.

Miscellaneous. Little change in total.

Centaurea nigra. Increased, very considerably so in some years.

Ranunculus spp. Decreased.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	88.97	86.43	82.21	83.96	78.85	86.23
L. . .	0.19	0.98	0.34	0.51	—	—
M. . .	10.84	12.59	17.45	15.53	21.15	13.77

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> . . .	16.43	6.43	3.31	4.23	9.33	11.27	+
<i>Festuca ovina</i> . . .	0.76	6.17	6.40	10.75	27.70	14.22	+
<i>Poa pratensis</i> . . .	1.45	6.56	7.41	1.38	0.62	0.42	—
„ <i>trivialis</i> . . .	31.90	22.32	4.35	2.71	—	—	—
<i>Avena pubescens</i> . . .	0.50	1.58	2.76	2.08	0.11	0.21	—
„ <i>flavescens</i> . . .	3.99	6.85	6.23	1.37	—	0.05	—
<i>Bromus mollis</i> . . .	21.92	10.55	4.55	0.83	—	—	—
<i>Lolium perenne</i> . . .	1.42	3.19	1.71	1.66	—	—	—
<i>Centaurea nigra</i> . . .	—	0.18	1.24	0.25	18.94	2.11	+
<i>Ranunculus spp.</i> . . .	1.53	0.63	0.72	2.58	0.06	—	—

Effect of Liming.

A. On herbage and yield.—Limed half is usually not very dissimilar to the unlimed portion. The herbage is rather more even, thick, and not so liable to lodge as when unlimed.

Effect on yield varies with season ; yield may be greater, equal to, or less than when no lime is applied.

B. On number of species.—Increased.

	Unlimed.	Limed.
1914 .	17	23
1919 .	15	22

C. On personnel of herbage.—

Graminaceæ. Reduced.

Leguminosæ. Increased.

Miscellaneous. Increased.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Avena pubescens</i> .	1914	0·11	4·96	+
	1919	0·21	7·61	+
<i>Poa pratensis</i> .	1914	0·62	3·78	+
	1919	0·42	1·80	+
<i>Alopecurus pratensis</i>	1914	1·98	4·37	+
	1919	1·27	5·85	+
<i>Agrostis vulgaris</i> .	1914	15·72	12·08	—
	1919	18·44	8·42	—
<i>Holcus lanatus</i> .	1914	7·01	5·45	—
	1919	22·34	9·95	—
<i>Anthoxanthum odoratum</i>	1914	14·75	6·74	—
	1919	17·39	7·79	—
<i>Dactylis glomerata</i> .	1914	9·33	6·90	—
	1919	11·27	23·19	+

Dactylis is the only important species on this plot on which the effect of liming varies with season as regards its reduction or increase.

19. AMMONIUM SALTS AND SUPERPHOS- PHATE OF LIME. (PLOT 4².)

Present Condition of Plot (Unlimed).

- (a) Herbage very characteristic, dark green and tufted, the tufts being chiefly *Festuca ovina* and *Anthoxanthum odoratum*. Usually many bare patches covered with a kind of dry peat of partly undecomposed foliage.
- (b) Starts into growth early in spring.
- (c) Yield usually medium, but very variable.
- (d) Eleven to eighteen species with occasional traces of several others.
- (e) *Graminaceæ* form bulk of herbage.
Leguminosæ absent.
Miscellaneous plants in fair quantity in some seasons very scanty in others.

Main Constituents of Association on Plot 4².

Festuca ovina. Most abundant species.

Anthoxanthum odoratum. Very abundant in some seasons, much less plentiful in others.

Agrostis vulgaris.

Alopecurus pratensis

Arrhenatherum avenaceum

Dactylis glomerata

Poa pratensis

} Quantity small and variable.

Rumex acetosa. Variable ; occasionally insignificant.

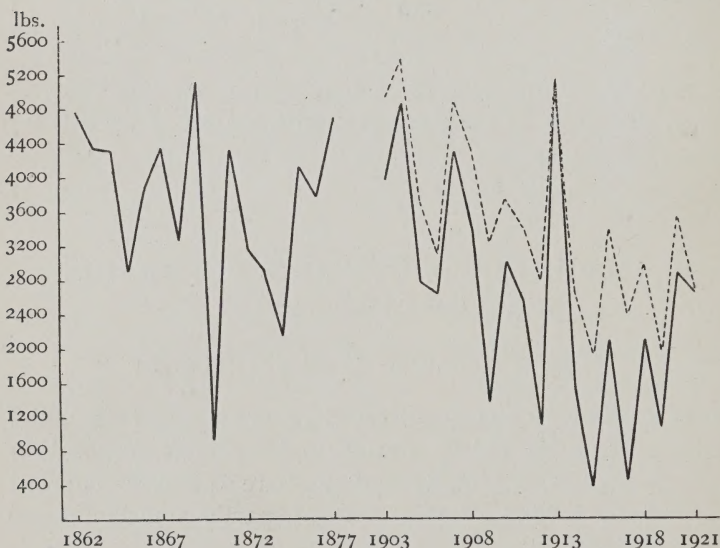


FIG. 8.—Curves showing Total Produce in lbs. per acre early and late in experiment. (First crop.) Plot 4².

— Unlimed. - - - - Limed.

OTHER SPECIES :—

Avena flavescens, *Av. pubescens*, *Bromus*, *Holcus*, *Lolium*, *Poa trivialis* ; *Lathyrus*, *Trifolium pratense* (both negligible) ; *Achillea*, *Centaurea*, *Galium*, *Heracleum*, *Leontodon*, *Luzula*, *Plantago*, *Scabiosa*, *Taraxacum*, *Tragopogon*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Considerable reduction in yield during the last ten years. Previously the yields had kept up to a fairly high level.

B. Reduction in number of species in all three groups of plants ; reduction real, not seasonal.

Number of Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	14	14	15	13	9	9	8
L. .	3	3	2	2	1	—	—
M. .	18	13	11	11	5	6	2
Total .	35	30	28	26	15	15	10

C. Changes in the personnel of the herbage.—

Graminaceæ.

Anthoxanthum odoratum. Increased ; very considerably so in some seasons.

Agrostis vulgaris. Reduced.

Holcus lanatus. Reduced.

Poa trivialis. Disappeared.

Lolium perenne. Disappeared.

Leguminosæ. Have quite disappeared.

Miscellaneous.

Rumex acetosa is now the only significant species, but is very variable. Even the traces of others do not appear in most seasons.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.
G. .	80.31	86.13	88.65	94.63	93.64	98.70	91.95
L. .	0.09	0.04	0.03	0.04	0.01	—	—
M. .	19.60	13.83	11.32	5.33	6.35	1.30	8.05

Change in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1903.	1914.	1919.	Inc. or Dec.
<i>Anthoxanthum odoratum</i> .	2·24	5·52	1·47	2·36	23·44	7·72	34·00	+
<i>Agrostis vulgaris</i> .	19·38	14·00	20·59	24·39	2·04	12·82	4·24	—
<i>Holcus lanatus</i> .	16·21	10·53	2·03	6·03	1·05	0·04	0·27	—
<i>Poa trivialis</i> .	8·14	2·15	2·10	0·31	0·24	—	—	—
<i>Lolium perenne</i> .	6·47	1·36	0·70	0·21	—	—	—	—
<i>Rumex acetosa</i> .	13·39	8·42	6·85	3·09	0·54	0·51	7·95	?

Effect of Liming.

A. On herbage and yield.—Herbage greatly improved ; less tussocky, growth more even, grass tall and thick, inclined to be rather rank ; limed area is dark green with new growth in spring, when the unlimed part is still brownish with previous year's dead grass.

Yield much improved.

B. On number of species.—No constant effect.

C. On personnel of herbage.

Balance of Gramineæ, Leguminosæ, and Miscellaneous species not affected.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Alopecurus pratensis</i> .	{	1914 2·49	42·19	+
		1919 1·41	76·05	+
<i>Poa pratensis</i> . .	{	1914 1·22	12·57	+
		1919 0·35	12·75	+
<i>Festuca ovina</i> . .	{	1914 72·88	34·84	—
		1919 47·80	7·74	—
<i>Anthoxanthum odoratum</i>	{	1914 7·72	7·55	No effect
		1919 34·00	1·09	—
<i>Agrostis vulgaris</i> .	{	1914 12·82	1·03	—
		1919 4·24	0·32	—
<i>Arrhenatherum avenaceum</i>	{	1914 0·25	0·02	—
		1919 3·09	—	—
<i>Dactylis glomerata</i> .	{	1914 1·01	—	—
		1919 0·57	0·14	—(?)
<i>Rumex acetosa</i> . .	{	1914 0·51	0·47	No effect
		1919 7·95	1·55	—

With *Anthoxanthum* and *Rumex* the action of lime varies with season ; it has no effect in years unfavourable to the growth of the species, but causes much reduction in good years.

N.B.—The total absence of *Arrhenatherum* and *Dactylis* from the limed samples in certain seasons.

20. AMMONIUM SALTS AND MIXED MINERAL MANURE WITHOUT SUPERPHOSPHATE, AFTER MINERALS AND AMMONIUM SALTS SUPPLYING THE CONSTITUENTS OF 1 TON OF HAY, 1865-1904. (PLOT 18.)

Present Condition of Plot (Unlimed).

- (a) Herbage very dark green in summer ; growth uneven ; many bare patches ; very brown in winter with dead *Festuca* and *Agrostis*, and dead tips of *Aira* leaves.
- (b) Starts into growth fairly early, but young green is much masked by the general brown coloration of plot.
- (c) Yield medium.
- (d) About twenty species, with occasional traces of several others.
- (e) In some seasons *Graminaceæ* form bulk of herbage ; in others a large proportion (30 per cent.) of *Miscellaneous* species are present.

Leguminosæ practically absent.

Main Constituents of Association on Plot 18.

Dactylis glomerata. Chief *Graminaceæ*, very abundant.

Festuca ovina } Very plentiful in some seasons.
Agrostis vulgaris }

Alopecurus pratensis } Much less plentiful than above
Anthoxanthum odoratum } species.

Arrhenatherum avenaceum } In small quantity ; very scanty
Holcus lanatus } in some seasons.

Rumex acetosa. Very variable; sometimes very plentiful (24 per cent.).

Conopodium denudatum } Vary much with season.
Centaurea nigra }

OTHER SPECIES:—

Aira, *Avena flavescens*, *Av. pubescens*, *Briza*, *Poa pratensis*; *Lathyrus*, *Lotus*, *Trifolium repens*; *Achillea*, *Carex*, *Cerastium*, *Galium*, *Heracleum*, *Luzula*, *Pimpinella*, *Scabiosa*, *Stellaria*, *Taraxacum*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. *Yield constant*, except for seasonal fluctuations, until after the change in manuring in 1905. From 1908 onwards a drop has occurred, but the seasonal fluctuations are still very marked.

B. *Considerable reduction in number of species*.—Unfortunately no figures are recorded which show whether the reduction was associated with the change of manuring in 1904.

Number of Species.

	1867.	1872.	1877.	1914.	1919.
G.	15	18	14	10	10
L.	4	4	4	1	0
M.	21	22	21	5	5
Total	40	44	39	16	15

C. *Change in the personnel of the herbage*.—

Graminaceæ and *Miscellaneous* plants are so variable in quantity that it is impossible to say whether they have really increased or decreased.

Graminaceæ.

Dactylis glomerata. Great increase.

Alopecurus pratensis. Increased.

Holcus lanatus. Great reduction.

Avena pubescens. Reduced.

„ *flavescens*. Reduced almost to disappearance.

Poa trivialis. Disappeared.

Briza media. Disappeared.

Cynosurus cristatus. Disappeared.

Lolium perenne. Disappeared.

Leguminosæ. Practically disappeared.

Miscellaneous.

Centaurea nigra. Increased.

Rumex acetosa. Very variable, probably increased.

Achillea millefolium. Reduced.

Ranunculus spp. Disappeared.

Percentage of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous Species*.

	1867.	1872.	1877.	1914.	1919.
G.	55.46	80.80	84.18	68.93	93.16
L.	5.01	3.57	1.99	—	0.05
M.	39.53	15.63	13.83	31.07	6.79

Change in Percentage of Certain Species.

	1867.	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Dactylis glomerata</i> . . .	1.79	1.20	1.28	36.90	33.84	+
<i>Alopecurus pratensis</i> . .	0.95	0.92	0.75	3.25	5.05	+
<i>Holcus lanatus</i>	12.78	7.32	17.45	0.89	2.36	—
<i>Avena pubescens</i>	2.87	2.58	1.94	0.05	0.11	—
„ <i>flavescens</i>	3.42	5.75	3.12	0.05	—	—
<i>Poa trivialis</i>	4.83	2.92	2.80	—	—	—
<i>Briza media</i>	0.02	0.45	0.12	—	—	—
<i>Cynosurus cristatus</i> . . .	0.18	0.97	0.32	—	—	—
<i>Lolium perenne</i>	5.15	3.37	6.45	—	—	—
<i>Centaurea nigra</i>	0.79	0.84	0.87	4.51	1.93	+
<i>Rumex acetosa</i>	24.33	1.97	4.66	1.10	24.49	+(?)
<i>Achillea millefolium</i> . . .	0.76	4.06	1.32	0.16	0.16	—
<i>Ranunculus spp.</i>	5.73	3.11	2.56	—	—	—

F. ORGANIC MANURES. (TABLE VI.)

21. FARMYARD MANURE AND FISH GUANO ALTERNATELY (EACH ONCE IN FOUR YEARS) AFTER CUT WHEAT STRAW, MINERALS AND AMMONIUM SALTS, 1856-1897, AND MINERALS AND AMMONIUM SALTS, 1898-1904. (PLOT 13.)

Present Condition of Plot (Unlimed).

- (a) Herbage very strong and tall, but inclined to lodge ;
little bottom grass. Not unlike that on plot 9 in
general appearance, though different in botanical
composition.
- (b) Starts into growth early in spring, especially in years that
farmyard manure is applied.
- (c) Yield heavy, and much less variable than on plots manured
with large dressings of artificial fertilisers.
- (d) Seventeen to twenty-four species, with occasional traces
of several others.
- (e) *Graminaceæ* form bulk of herbage.
Leguminosæ very scanty.
Miscellaneous plants in small quantity in most seasons,
occasionally more plentiful.

Main Constituents of Association on Plot 13.

<i>Alopecurus pratensis</i>	} Chief <i>Graminaceæ</i> .
<i>Arrhenatherum avenaceum</i>	
<i>Holcus lanatus</i>	} Vary with season in relative abundance.
<i>Festuca ovina</i>	
<i>Agrostis vulgaris</i>	
<i>Dactylis glomerata</i>	
<i>Anthoxanthum odoratum</i>	
<i>Poa pratensis</i> . Usually scanty.	

Rumex acetosa. Quantity very variable with season.

Conopodium denudatum. Rather conspicuous in some seasons.

OTHER SPECIES:—

Avena flavescens, *Av. pubescens*, *Briza*, *Poa trivialis*; *Lathyrus*; *Achillea*, *Anthriscus*, *Bellis*, *Centaurea*, *Cerastium*, *Galium*, *Heracleum*, *Leontodon*, *Luzula*, *Pimpinella*, *Plantago*, *Stellaria*, *Taraxacum*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Some reduction in yield from 1878-1904, followed by a sudden drop with the change in manuring after 1904. Since then the tendency has been for the yield to improve and to become relatively less fluctuating of late years.

B. Number of species has remained fairly constant, with rather considerable seasonable variations.

C. Changes in the personnel of the herbage.—The changes are confined to the *Graminaceæ*, and have probably occurred since the change of manuring in 1904, but unfortunately no complete separation of this plot was made in 1903.

Graminaceæ.

Anthoxanthum odoratum. Increased.

Alopecurus pratensis. Increased.

Arrhenatherum avenaceum. Increased.

Festuca ovina. Probably increased.

Holcus lanatus. Probably increased.

Poa pratensis. Reduced.

Dactylis glomerata. Much reduced.

Lolium perenne. Disappeared.

Leguminosæ. No change, very little present.

Miscellaneous. Large seasonal fluctuations.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1862.	1867.	1872.	1877.	1914.	1919.
G. . .	90.43	86.32	95.39	92.04	96.48	79.83
L. . .	0.30	0.12	0.32	—	0.46	0.07
M. . .	9.27	13.56	4.29	7.96	3.06	20.09

Changes in Percentage of Certain Species.

	1862.	1867.	1872.	1877.	1914.	1919.	Inc. Dec.
<i>Anthoxanthum odoratum</i>	0.69	1.89	0.42	0.33	3.90	5.19	+
<i>Alopecurus pratensis</i>	3.36	4.53	5.89	6.78	18.21	22.20	+
<i>Arrhenatherum avenaceum</i>	0.42	2.49	9.17	11.08	24.09	17.26	+
<i>Festuca ovina</i>	2.27	6.82	3.60	3.57	14.40	5.51	+
<i>Holcus lanatus</i>	5.35	4.70	2.71	4.57	14.40	7.19	+
<i>Poa pratensis</i>	3.91	10.25	11.44	10.09	0.83	1.68	—
<i>Dactylis glomerata</i>	27.88	20.28	43.05	40.75	7.52	9.19	—
<i>Lolium perenne</i>	2.75	1.21	0.16	0.11	—	—	—

Effect of Liming.

A. On herbage and yield.—Usually no very marked effect on herbage; occasionally limed area does not look as well as the unlimed. Inclined to lodge.

Yield sometimes increased in early years, but since 1909 liming has always caused more or less depression.

B. On number of species.—Slightly increased.

	Unlimed.	Limed.
1914 .	17	20
1919 .	20	23

C. On personnel of herbage.—

Balance of Graminaceæ, Leguminosæ, and Miscellaneous species little or not affected.

Alopecurus varies with season in its response to liming on this plot.

		Unlimed.	Limed.	Increase or Decrease due to Liming.
		Per cent.	Per cent.	
<i>Arrhenatherum avenaceum</i>	{ 1914	24.09	39.90	+
	1919	17.26	20.47	+
<i>Poa pratensis</i>	{ 1914	0.83	1.14	+
	1919	1.68	3.90	+
<i>Alopecurus pratensis</i>	{ 1914	18.21	18.12	No effect
	1919	22.20	35.18	+
<i>Agrostis vulgaris</i>	{ 1914	11.65	2.32	—
	1919	11.02	3.33	—
<i>Festuca ovina</i>	{ 1914	14.40	10.60	—
	1919	5.51	4.71	—
<i>Anthoxanthum odoratum</i>	{ 1914	3.90	1.44	—
	1919	5.19	1.95	—
<i>Rumex acetosa</i>	{ 1914	1.79	0.63	—
	1919	15.10	6.26	—

22. FARMYARD MANURE EVERY FOURTH YEAR, AFTER NITRATE OF SODA AND MINERALS, 1872-1904. (PLOT 19.)

Present Condition of Plot (Unlimed).

- (a) Herbage patchy and very dark green early in year ; later on gives a good thick growth of moderately long, mixed herbage ; rather uneven, some bare patches.
- (b) Starts into growth early in spring, and grows rapidly in years that manure is applied.
- (c) Yield medium.
- (d) Twenty-three to thirty species, with occasional traces of several others.
- (e) All three groups of plants are well represented, the *Leguminosæ* showing the most noticeable variations with season, from 6 to 19 per cent.

Main Constituents of Association on Plot 19.

<i>Agrostis vulgaris</i>	} Chief Graminaceæ.
<i>Alopecurus pratensis</i>	
<i>Dactylis glomerata</i>	
<i>Festuca ovina</i>	

Arrhenatherum avenaceum

Avena flavescens

„ *pubescens*

Anthoxanthum odoratum

Holcus lanatus

Poa trivialis

Bromus mollis. Quantity usually small.

} Usually fairly well represented,
but vary with season in relative
abundance.

Lathyrus pratensis. Chief *Leguminosæ*.

Rumex acetosa. Probably chief *Miscellaneous* species.

Achillea millefolium

Anthriscus sylvestris

Centaurea nigra

Conopodium denudatum

Ranunculus spp.

} Vary with season in relative abundance.

OTHER SPECIES:—

Aira, *Cynosurus*, *Lolium*, *Poa pratensis*; *Lotus*, *Trifolium pratense*, *Tri. repens*; *Ajuga*, *Cerastium*, *Luzula*, *Plantago*, *Prunella*, *Stellaria*, *Taraxacum*, *Tragopogon*, *Veronica*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Yield constant, with seasonal fluctuations, until the change in manuring in 1905. Then a rapid drop occurred, but after a few years the yield again tended to become more constant.

B. Some reduction of species, which has only become really evident during the last few years, after the change in manuring.

	1872.	1877.	1908.	1914.	1919.
G. . . .	16	16	?	13	13
L. . . .	4	5	?	4	2
M. . . .	21	18	?	14	15
Total .	41	39	39	31	30

*C. Changes in the personnel of the herbage.—**Graminaceæ.* Reduced.*Alopecurus pratensis.*—Increased.*Arrhenatherum avenaceum.* Increased.*Dactylis glomerata.* Increased.*Bromus mollis.* Has come in.*Holcus lanatus.* Reduced.*Lolium perenne.* Reduced.*Cynosurus cristatus.* Disappeared.*Leguminosæ.* Variable, but often much increased.*Miscellaneous.* Increased.*Centaurea nigra.* Probably increased.*Rumex acetosa.* Probably increased.*Anthriscus sylvestris.* Has come in.*Conopodium denudatum.* Possibly reduced.*Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.*

	1872.	1877.	1905.	1914.	1917.	1919.
G. . .	89.35	80.95	64.00	78.82	68.70	75.22
L. . .	2.51	8.72	17.80	9.96	21.38	6.17
M. . .	8.14	10.33	18.20	11.22	9.92	18.61

Change in Percentage of Certain Species.

	1872.	1877.	1914.	1919.	Inc. or Dec.
<i>Alopecurus pratensis</i> . .	0.23	5.40	13.25	22.25	+
<i>Arrhenatherum avenaceum</i> . .	0.01	—	3.69	7.89	+
<i>Dactylis glomerata</i> . .	0.67	2.43	11.82	15.79	+
<i>Bromus mollis</i> . .	—	—	2.12	0.20	+
<i>Holcus lanatus</i> . .	14.03	21.19	3.48	2.13	—
<i>Lolium perenne</i> . .	4.14	1.23	0.27	0.43	—
<i>Cynosurus cristatus</i> . .	1.17	2.54	—	—	—
<i>Centaurea nigra</i> . .	0.08	0.07	1.84	0.39	+
<i>Rumex acetosa</i> . .	0.72	2.65	2.05	8.37	+
<i>Anthriscus sylvestris</i> . .	—	—	3.01	0.51	+
<i>Conopodium denudatum</i> .	1.96	4.47	0.27	1.74	—

23. FARMYARD MANURE EVERY FOURTH YEAR WITH NITRATE OF SODA AND MINERALS IN INTERVENING YEARS, AFTER NITRATE OF POTASH AND SUPERPHOSPHATE, 1872-1904. (PLOT 20.)

Present Condition of Plot (Unlimed).

- (a) Herbage mixed and well grown, but rather irregular ; some bare patches.
- (b) Starts into growth early in spring, especially in years that farmyard manure is applied.
- (c) Yield fairly heavy, higher than on plots 18 and 19.
- (d) Twenty-seven to thirty-three species, with occasional traces of a few others.
- (e) All three groups of plants are well represented.
Graminaceæ. Relatively constant in proportion.
Leguminosæ } Show considerable variation with
Miscellaneous species } season.

Range of Proportion from 1910-1919.

	Lowest per cent.	Highest per cent.
G. . .	63.49 (1912)	82.02 (1914)
L. . .	4.70 (1919)	24.95 (1917)
M. . .	6.14 (1916)	29.79 (1912)

Main Constituents of Association on Plot 20.

- Agrostis vulgaris*
 - Alopecurus pratensis*
 - Avena pubescens*
 - Dactylis glomerata*
 - Festuca ovina*
 - Holcus lanatus*
 - Arrhenatherum avenaceum*
 - Avena flavescens*
 - Poa trivialis*
 - Anthoxanthum odoratum*
 - Bromus mollis*
- Usually chief *Graminaceæ*, but vary with season in relative abundance.
- Well represented.
- Very variable in quantity.

Lathyrus pratensis. Chief Leguminosæ.

Anthriscus sylvestris. Small quantity, fairly constant.

Achillea millefolium

Centaurea nigra

Conopodium denudatum } Small quantity, variable.

Ranunculus spp.

Rumex acetosa

OTHER SPECIES:—

Briza, *Lolium*, *Poa pratensis*; *Lotus*, *Trifolium pratense*, *Tri. repens*; *Agrimonia*, *Ajuga*, *Cerastium*, *Galium*, *Luzula*, *Plantago*, *Prunella*, *Stellaria*, *Taraxacum*, *Tragopogon*, *Veronica*, *Viola*.

Outline of Principal Changes during the Experimental Period, 1877-1919.

A. Yield constant, except for seasonal fluctuations, till after the change in manuring in 1905; after 1908 a drop occurred, but the yield now shows signs of improving.

B. Some reduction of species, which set in after the change of manuring in 1904.

Number of Species.

	1872.	1877.	1908.	1914.	1919.
G. . . .	15	16	?	13	13
L. . . .	5	4	?	3	1
M. . . .	22	18	?	12	15
Total .	42	38	39	28	29

C. Changes in the personnel of the herbage.—

Graminaceæ. Reduced.

Alopecurus pratensis. Increased.

Arrhenatherum avenaceum. Increased.

Avena pubescens. Increased.

Dactylis glomerata. Increased.

Bromus mollis. Has come in.

Anthoxanthum odoratum. Reduced.

Agrostis vulgaris. Reduced.

Lolium perenne. Reduced.

Cynosurus cristatus. Disappeared.

Briza media. Disappeared.

Leguminosæ. Increased ; very variable.

Lathyrus pratensis. Increased.

Miscellaneous.—Very variable, probably increased to 1904, and then dropped to original proportions after the change in manuring.

Centaurea nigra. Increased.

Anthriscus sylvestris. Has come in.

Percentage of Graminaceæ, Leguminosæ, and Miscellaneous Species.

	1872.	1877.	1905.	1914.	1917.	1919.
G. . .	87.12	86.11	62.80	84.13	66.13	81.84
L. . .	2.04	3.66	23.40	6.52	24.95	4.72
M. . .	10.84	10.23	13.80	9.35	8.92	13.44

Change in Percentage of Certain Species.

	1872.	1877.	1914.	1919.	Increase or Decrease.
<i>Alopecurus pratensis</i> . .	1.22	6.80	10.86	30.20	+
<i>Arrhenatherum avenaceum</i> . .	0.01	0.01	4.05	4.58	+
<i>Avena pubescens</i> . .	1.02	2.40	6.17	10.12	+
<i>Dactylis glomerata</i> . .	0.30	1.15	9.70	12.46	+
<i>Bromus mollis</i> . .	—	—	4.75	0.23	+
<i>Anthoxanthum odoratum</i> . .	7.17	3.51	0.58	1.15	—
<i>Agrostis vulgaris</i> . .	31.35	10.36	4.37	6.54	—
<i>Lolium perenne</i> . .	2.03	3.61	0.26	0.30	—
<i>Cynosurus cristatus</i> . .	1.15	1.51	—	—	—
<i>Briza media</i> . .	0.72	0.19	—	—	—
<i>Lathyrus pratensis</i> . .	0.10	2.73	6.23	4.70	+
<i>Centaurea nigra</i> . .	0.01	0.16	2.51	1.43	+
<i>Anthriscus sylvestris</i> . .	—	—	2.76	2.49	+

CHAPTER IVB.

EFFECT OF MANURES AND LIME ON INDIVIDUAL SPECIES.

A. GRAMINACEÆ.

AGROSTIS VULGARIS.

OCCURS in samples from every plot, limed and unlimed.

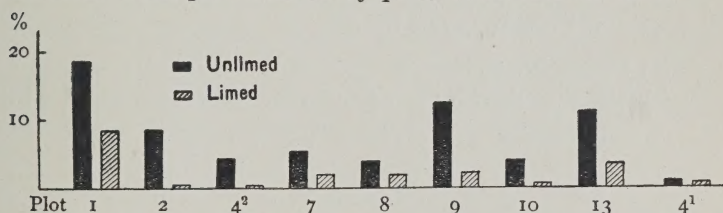


FIG. 9.—Percentage of *Agrostis vulgaris* in herbage, 1919.

UNLIMED.

Quantity fairly large (to 18 per cent.)—

- 1 (amm. salts).
- 3, 5¹ (unmanured).
- 4² (super. and amm. salts).
- 5² (mins. after amm. salts to 1897).
- 9, 18 (mins. and amm. salts).
- 13 (F.Y.M.* and fish guano).
- 15 (mins.).
- 17 (nitrate of soda).

Quantity medium (to 9 per cent.)—

- 2, 12 (unmanured).
- 6, 7, 8 (mins.).
- 10 (mins. without potash, and amm. salts).
- 16 (nitrate of soda and mins.).
- 19 (F.Y.M.).
- 20 (F.Y.M., mins., and sodium nitrate).

* F.Y.M. = Farmyard manure.

Quantity very small (usually below 1 per cent.)—

- 4¹ (superphosphate).
 11¹, 11² (mins. and heavy amm. salts).
 14 (mins. and heavy nitrate of soda).

Agrostis encouraged by—

- (a) Starved soils.
 (b) Mins. and nitrogenous manures, alone or in combination, except in very heavy dressings.
 (c) Organic manures.

Agrostis not encouraged by—

- (a) Superphosphate.
 (b) Heavy dressings of nitrogenous manures with minerals.

LIMED.

Considerable decrease—

- 1, 4², 9, 10 (amm. salts with or without minerals).
 2, 3 (unmanured).
 7, 8 (mins.).
 13 (F.Y.M. and fish guano).
 16 (mins. and nitrate of soda).

Little effect—

- 4¹ (superphosphate).
 11¹, 11² (mins. and heavy amm. salts).

Plots on which Agrostis was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903 *	—	—	5 ¹	—	—	—
1914	—	1, 2, 3, 4 ² , 5 ¹ , 5 ² , 6, 9	7, 8, 12, 15, 17, 18	—	1	—
1919	—	1, 3, 6, 9, 15, 18	2, 4 ² , 5 ² , 7, 11 ¹ , 13	—	—	—

* Returns incomplete.

SUMMARY.

Agrostis is usually present in fair quantity, unless the manuring is very heavy, but it is very much discouraged by liming.

***Agrostis Vulgaris* in Plant Communities.**

UNLIMED.

Agrostis is a marked feature of all the associations except the specialised or reduced ones occurring with very heavy manuring or superphosphate alone. The elimination of *Agrostis* from the *Dactylis-Holcus-Festuca-Avena pubescens* community in the latter case is noteworthy, as the herbage is not of the coarse rank nature which would kill out *Agrostis* by sheer weight of competition.

LIMED.

Agrostis is a less conspicuous element of the various associations owing to the reduction brought about by liming, and with amm. salts and superphosphate (plot 4²) and nitrate and minerals (plot 16) it is almost eliminated from the communities.

AIRA CÆSPITOSA.

Traces occur on plots 5¹, 8, 10, 18, 19.

The species is present on fewer plots than in 1877, and the quantity is also reduced.

ALOPECURUS PRATENSIS.

Occurs in samples from every plot, limed and unlimed.

UNLIMED.

Quantity large (usually 10-50 per cent.)—

- 10 (mins. without potash, and amm. salts).
- 11² (mins. and heavy amm. salts and silicates).
- 13 (F.Y.M. and fish guano alternately).
- 14, 16 (mins. and sodium nitrate).
- 17 (sodium nitrate).

Quantity large (usually 10-50 per cent.) (*cont.*)—

15 (mins. after nitrate of soda to 1875).

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda).

Quantity variable or increasing (4-11 per cent.)—

5² (mins. after amm. salts to 1897).

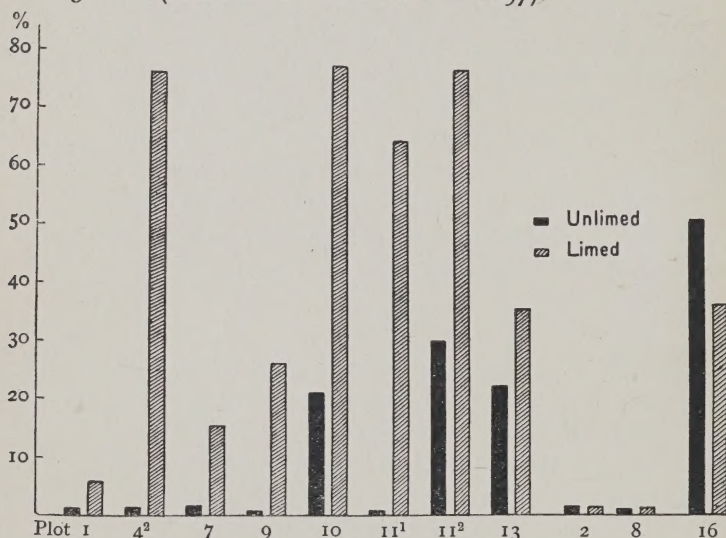


FIG. 10.—Percentage of *Alopecurus pratensis* in herbage, 1919.

Quantity small (usually under 5 per cent.)—

2, 3, 12 (unmanured).

5¹ (unmanured after amm. salts to 1897).

1 (amm. salts).

4¹ (superphosphate).

4² (super. and amm. salts).

6, 7, 8 (mins. with and without potash).

9, 11¹ (mins. with potash, and amm. salts).

18 (mins. without super., and amm. salts).

Alopecurus encouraged by—

(a) Nitrate of soda, whether alone or mixed with minerals.

(b) Organic manures.

Alopecurus not encouraged by—

- (a) Starved soils.
- (b) Most incomplete manures.
- (c) Heavy dressings of ammonium salts, except in absence of potash or presence of silicates.

LIMED.

Great increase—

- 4² (super. and amm. salts).
- 9, 10, 11¹, 11² (mins. with and without potash, and amm. salts).

Considerable increase—

- 1 (amm. salts).
- 7 (complete mins.).
- 13 (F.Y.M. and fish guano alternately).

Plot on which liming has little effect or causes decrease—

- 16 (mins. and nitrate of soda).

Initial quantity not increased by liming—

- 2, 3, 4¹, 8.

On plots with *high* soil acidity and a good supply of plant nutrients (9, 10, 11¹, 11², 4²) liming has caused an exceedingly great increase, e.g. from 1 to 64 per cent., 21 to 77 per cent., 2 to 42 per cent., 2 to 76 per cent., etc.

On plots with *low* soil acidity liming has had little or no effect on the relative quantity, irrespective of whether plant nutrients are plentiful or not.

Plots on which Alopecurus forms Largest Percentage of Herbage.

TABLE A.

	Unlimed Plots.	Limed Plots.
1914	16	4 ² , 10, 11 ¹ , 11 ²
1919	13, 16	4 ² , 10, 11 ¹ , 11 ² , 13, 16

TABLE B.*

	Unlimed Plots.
1914	15, 17
1919	14, 15, 17, 19, 20

* The plots given under Table B are wholly unlimed.

SUMMARY.

Alopecurus pratensis appears to respond readily to a plentiful supply of nutrients, provided a sufficiency of lime is applied. It evidently needs an abundant nitrogen supply, but cannot take advantage of it if the soil is too acid, and the encouragement by lime is very marked.

Alopecurus Pratensis in Plant Communities.

Alopecurus marks out the plant associations on certain plots, on which it is often dominant, as follows :—

UNLIMED.

- (a) Heavy nitrogenous and mineral manures (plots 10, 11², 14), not too acid. *Alopecurus-Arrhenatherum*, usually with the addition of *Festuca*, *Anthoxanthum*, or *Holcus*.

Comparatively few miscellaneous or leguminous plants.

- (b) Less heavy, but fair manuring (plots 15, 16, 17, 19, 20). *Alopecurus* plentiful, but other members vary with season and comprise *Festuca*, *Agrostis*, *Dactylis*, *Lathyrus*, with occasionally *Holcus*, *Bromus*, *Plantago*, or *Achillea*.

A fair proportion of miscellaneous and leguminous plants always present.

- (c) Organic manures, plot 13. Cf. (a), plus *Agrostis* and *Dactylis*.

LIMED.

- (a) Minerals only, plot 7 : *Dactylis-Alopecurus-Festuca-Lathyrus*, with *Bromus* in some years.
- (b) Superphosphate and amm. salts (plot 4²) : *Alopecurus-Poa pratensis-Festuca*, but the two latter take a subordinate

place in seasons that are specially favourable to *Alopecurus*.

(c) Heavy nitrogenous and mineral manures.

(1) Plots 9 and 11¹: *Arrhenatherum-Alopecurus*, with *Holcus* and *Dactylis*.

(2) Plots 10, 11²: *Alopecurus-Arrhenatherum*, with *Anthoxanthum*, *Festuca*, *Dactylis*, *Poa pratensis*.

Few miscellaneous and no leguminous plants.

(d) Organic manures, plot 13: much as unlimed (b), but little *Agrostis*.

N.B.—It is noticeable that with liming the *Alopecurus* associations are more varied than on the unlimed plots, and that each plot on which great increase has occurred has a distinctive association of its own. Also, *Agrostis* disappears as a chief element in these groups.

ANTHOXANTHUM ODORATUM.

Occurs in samples from every plot except one receiving lime (11²).

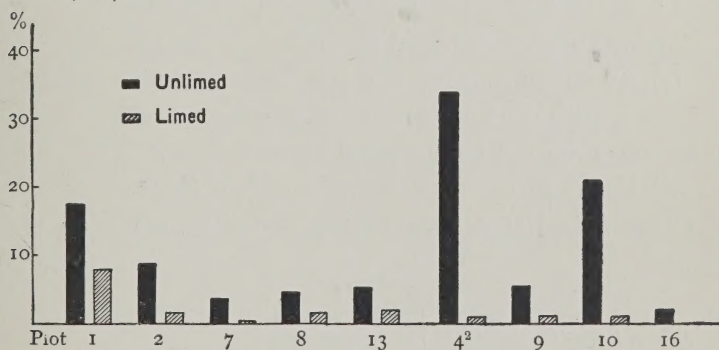


FIG. 11.— Percentage of *Anthoxanthum odoratum* in herbage, 1919.

UNLIMED.

Quantity fairly large (usually 8-25 per cent.)—

1 (amm. salts) (15-25 per cent.).

5¹ (unman. after amm. salts to 1897) (8-12 per cent.).

Quantity fairly large but very variable—

- 4² (super. and amm. salts) (8-34 per cent.).
- 9 (mins. with potash, and amm. salts) (5-38 per cent.).
- 10 (mins. without potash, and amm. salts) (21-49 per cent.).

Quantity small (usually under 8 per cent.)—

- 2, 3, 12 (unmanured).
- 4¹ (superphosphate).
- 5² (mins. after amm. salts to 1897).
- 6, 7, 8, 15 (mins. with and without potash).
- 13 (F.Y.M. and fish guano alternately).
- 16 (mins. and nitrate of soda).
- 17 (nitrate of soda).
- 18 (mins. without super., and amm. salts).
- 19 (F.Y.M.).
- 20 (F.Y.M., mins., and nitrate of soda).

Quantity very small (usually under 1 per cent.)—

- 11¹, 11² (mins. and heavy amm. salts, with and without silicates).
- 14 (mins. and heavy nitrate of soda).

Anthoxanthum encouraged by—

- (a) Ammonium salts, alone or with minerals (except with very heavy dressings).

Anthoxanthum not encouraged by—

- (a) Heavy nitrogenous manures and minerals.

Other manurial dressings have had little effect on the species.

LIMED.

Occasional increase due to liming—

- 11¹ (mins. and heavy amm. salts).

Appreciable decrease—

- 1 (amm. salts).
- 2, 3 (unmanured).
- 4¹ (superphosphate).
- 7, 8 (mins. with and without potash).
- 13 (F.Y.M. and fish guano alternately).

Great decrease—

- 4² (super. and amm. salts) (34 to 1 per cent. in 1919 ; not evident every season).
 9, 10 (mins. with and without potash, and amm. salts) (21 to 1 per cent., 49 to 15 per cent., 36 to 13 per cent., etc.).

Almost or entirely suppressed—

- 16 (mins. and nitrate of soda).
 11² (mins. and amm. salts and silicates).

Plots on which Anthoxanthum was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	4 ² , 5 ¹ , 9, 17	—	—	—	—
1914	9, 10	—	1, 4 ² , 5 ²	—	—	9
1919	—	4, 5 ¹ , 10	—	—	—	—

* Returns incomplete.

SUMMARY.

Anthoxanthum odoratum appears to flourish best on well-manured soil on which acid conditions prevail. It is, however, crowded out by other rank-growing grasses with very heavy nitrogenous manuring, and is usually reduced by liming.

Anthoxanthum Odoratum in Plant Communities.

UNLIMED.

- (a) Unmanured (plots 2, 3, 12) and nitrate of soda (plot 17) : very mixed associations, including *Anthoxanthum* in variable proportions.
 (b) Unmanured after ammonium salts (plot 5¹) : *Festuca-Agrostis-Anthoxanthum-Dactylis-Rumex-Centaurea*.
 (c) Ammonium salts with and without superphosphate (plots 1, 4²) : *Festuca-Anthoxanthum-Agrostis-Rumex* with *Dactylis*, *Holcus*, and *Centaurea* on plot 1.

- (d) Ammonium salts and minerals, with or without potash (plots 9, 10): *Arrhenatherum-Anthoxanthum-Festuca-Holcus* with *Agrostis* or *Alopecurus*.

LIMED.

- (a) Ammonium salts with superphosphate (plot 4²): *Alopecurus-Poa pratensis-Festuca-Anthoxanthum*. In absence of superphosphate (plot 1) association is very varied.
- (b) Ammonium salts and minerals, with and without potash (plots 9, 10): *Alopecurus-Arrhenatherum-Festuca-Anthoxanthum*, with *Dactylis* and *Poa pratensis*.

ARRHENATHERUM AVENACEUM.

Occurs in samples from every plot, limed and unlimed.

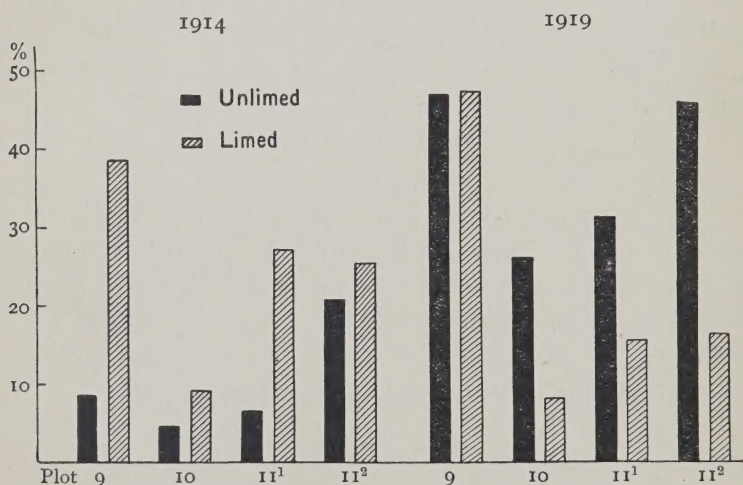


FIG. 12.—Percentage of *Arrhenatherum avenaceum* in herbage showing variable effect of liming in different seasons.

UNLIMED.

Quantity may be large: variable (up to 42 per cent.).

9, 10, 11¹, 11² (mins. and amm. salts).

13 (F.Y.M. and fish guano alternately).

14 (mins. and heavy nitrate of soda).

Quantity usually small (about 2-7 per cent.)—

- 6, 7, 8, 15 (mins. with and without potash).
- 12 (unmanured).
- 16 (mins. and nitrate of soda).
- 19 (F.Y.M.).
- 20 (F.Y.M., mins., and nitrate of soda).

Quantity usually very small (under 2 per cent.)—

- 1 (amm. salts).
- 2, 3 (unmanured).
- 4¹ (super.).
- 4² (super. and amm. salts).
- 5¹ (unmanured after amm. salts to 1897).
- 5² (mins. after amm. salts to 1897).
- 17 (nitrate of soda).
- 18 (mins. without super. and amm. salts).

Arrhenatherum encouraged by—

- (a) Heavy nitrogenous dressings with minerals.
- (b) Frequent applications of organic manures.

Arrhenatherum not encouraged by—

- (a) Nitrogenous manures alone.
- (b) Starved soils.
- (c) Most incomplete manures.

LIMED.

Apparent increase due to liming—

- 8 (mins. without potash).
- 13 (F.Y.M. and fish guano alternately).

*Effect variable with season—*sometimes decrease, sometimes increase, frequently to a very marked extent—

- 9, 10, 11¹, 11² (mins. and amm. salts). (See table on p. 98.)

Little effect—

- 1, 2, 3, 4¹, 4², 7, 16.

Variable Effect of Liming on Heavily Manured Plots.

	Effect of Liming, 1914.	Effect of Liming, 1919.
Plot 9	Increase from 8 to 38 per cent.	No effect.
„ 10	„ „ 5 to 9 „	Decrease from 26 to 8 per cent.
„ 11 ¹	„ „ 7 to 27 „	„ „ 31 to 15 „
„ 11 ²	„ „ 20 to 25 „	No effect.

Plots on which Arrhenatherum was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	9	—	11 ¹ , 14	—	—	—
1914	13, 14	11 ¹ , 11 ²	—	9, 13	11 ¹ , 11 ²	—
1919	9, 10, 11 ²	8, 11 ¹ , 13, 14	19	8, 9	10, 11 ¹ , 11 ² , 13	—

* Returns incomplete.

SUMMARY.

Arrhenatherum avenaceum is much encouraged by heavy complete manuring, whether with organic or artificial fertilisers. In other cases comparatively little is present. The effect of liming is very variable, large increase or decrease often occurring on the same plot in different seasons.

Arrhenatherum Avenaceum in Plant Communities.

UNLIMED.

- (a) Minerals without potash (plot 8) : *Festuca-Holcus-Arrhenatherum-Agrostis-Plantago*.
- (b) Very heavy nitrogenous manures and minerals.
- (a) Nitrate of soda (plot 14) : *Alopecurus-Arrhenatherum*.
- (β) Ammonium salts (plot 11¹) : *Holcus-Arrhenatherum*.
- (γ) Ammonium salts and silicate of soda (plot 11²) : *Holcus-Arrhenatherum-Alopecurus*.

(c) Heavy ammonium salts and minerals (plot 9) : *Arrhenatherum-Anthoxanthum-Festuca-Agrostis-Holcus-Rumex*.

In absence of potash (plot 10), *Alopecurus* replaces *Agrostis*.

(d) Frequent organic manuring (plot 13) : *Alopecurus-Arrhenatherum-Agrostis-Festuca-Dactylis-Holcus*.

LIMED.

(a) Minerals without potash (plot 8) : *Festuca-Arrhenatherum-Avena pubescens-Briza-Centaurea-Plantago*.

(b) Heavy nitrogenous manures and minerals (plots 9, 11¹, 11²) : *Alopecurus-Arrhenatherum-Dactylis*, with or without much *Holcus*.

In absence of potash (plot 10) *Alopecurus-Arrhenatherum* with *Anthoxanthum*, *Festuca*, and *Poa pratensis*, according to season.

(c) Frequent organic manuring (plot 13). As *Unlimed* (d) without *Agrostis*.

AVENA FLAVESCENS.

UNLIMED.

Quantity medium (up to 9 per cent.)—

19 (F.Y.M.).

20 (F.Y.M., mins. and nitrate of soda).

Quantity small (to 3·5 per cent.)—

2, 3, 12 (unmanured).

4¹ (superphosphate).

6, 7, 8, 15 (mins.).

14, 16, 17 (nitrate of soda, with or without minerals).

13 (F.Y.M. and fish guano).

Suppressed—

1, 4², 9, 10, 11¹, 11², 18 (amm. salts, with or without mins.)

5¹, 5² (unman. and mins., after amm. salts to 1897).

Avena encouraged by—

(a) Organic manures.

Avena suppressed by—

(a) Ammonium salts.

With other types of manures it merely maintains a footing.

LIMED.

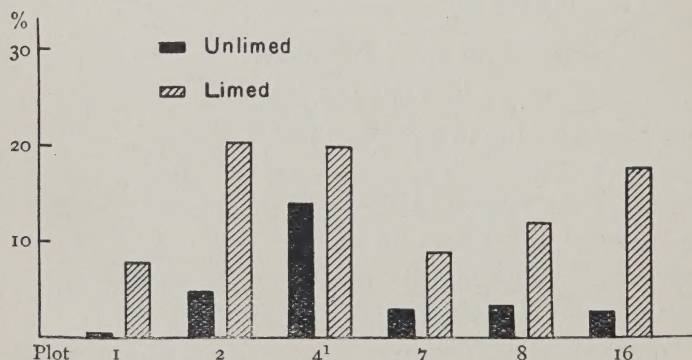
Little effect; a possible slight increase in some cases, as on plots 2, 3, 4¹, 7, 8.

Avena Flavescens in Plant Communities.

A very insignificant member of all associations in which it occurs, except occasionally with F.Y.M.

AVENA PUBESCENS.

This species is generally distributed over the area, but is entirely absent from a few plots, and on some others is present in such small quantities that it does not appear in the samples.

FIG. 13.—Percentage of *Avena pubescens* in herbage, 1919.**UNLIMED.**

Present in fair amount (usually over 5 per cent.; reaching 14 per cent).

4¹ (super.).

6 (mins.).

20 (F.Y.M., mins., and sodium nitrate).

Quantity usually small (1-5 per cent.)—

- 2, 3, 12 (unmanured).
- 5² (mins., after amm. salts to 1897).
- 7, 8, 15 (mins. with and without potash).
- 14, 16 (mins. and nitrate of soda).
- 17 (nitrate of soda).
- 19 (F.Y.M.).

Almost or entirely suppressed.—

- 1 (amm. salts).
- 4² (super. and amm salts).
- 5¹ (unman., after amm. salts to 1897).
- 9, 10, 11¹, 11² (mins. and amm. salts).
- 13 (F.Y.M. and fish guano alternately).
- 18 (mins. without super., and amm. salts).

Avena pubescens encouraged by—

- (a) Minerals, especially superphosphate.
- (b) Nitrate of soda, alone or with minerals.

Avena pubescens not encouraged by

- (a) Ammonium salts, alone or with minerals.
- (b) Frequent dressings of organic manures.

LIMED.

Great increase in quantity—

- 1 (amm. salts).*
- 2, 3 (unmanured).
- 16 (mins. and nitrate of soda).

Considerable increase in quantity—

- 4¹ (super. and amm. salts).
- 7, 8 (mins. with and without potash).

No effect—

- 4², 9, 10, 11¹, 11², 13.

* *Avena* is practically absent from the unlimed part of this plot.

Plots on which Avena pubescens was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	4 ¹ , 6, 8	—	—	—	—
1914	—	4 ¹	—	—	2, 3, 4 ¹ , 8	16
1919	4 ¹	—	—	2, 3, 4 ¹	8	7, 16

* Returns incomplete.

SUMMARY.

Avena pubescens is very intolerant of ammonium salts, otherwise it is of general distribution. Liming is so advantageous to the species that it is by this means often brought within the first three grasses in order of dominance.

Avena Pubescens in Plant Communities.

UNLIMED.

- (a) Superphosphate (plot 4¹): *Dactylis-Holcus-Festuca-Avena pubescens*.
- (b) Minerals (plots 6, 7, 8): *Festuca-Dactylis-Agrostis-Avena pubescens-Lathyrus*.*

Where *Avena* occurs on other plots it is a rather insignificant member of mixed associations.

LIMED.

- (a) Unmanured (plots 2, 3): *Avena pubescens-Festuca-Holcus-Centaurea-Plantago*, with *Briza*, *Leontodon*, and *Dactylis* on occasion.
- (b) Incomplete mineral manures (plot 4¹): *Avena pubescens-Festuca-Holcus-Lathyrus* or *Briza*.
- (c) Minerals and nitrate of soda (plot 16): *Alopecurus-Dactylis-Avena pubescens-Festuca*.

* Throughout the earlier years of the experiment, when *Lathyrus* often grew rampantly, it was repeatedly noticed that the *Avena pubescens* growing among the beds of *Lathyrus* was much more luxuriant than that outside, indicating a very close association between these two plants when they occur in proximity.

BRIZA MEDIA.

Absent from most plots.

UNLIMED.

Present on plots—

- 2, 3, 12 (unmanured).
- 4¹ (superphosphate).
- 8 (mins. without potash).
- 17 (nitrate of soda).

Quantity usually small (under 5 per cent., but reached 20 per cent. on plot 3 in 1903, and 10 per cent. on plot 12 in 1914).

Absent from plots—

1, 4², 5¹, 5², 6, 7, 9, 10, 11¹, 11², 13, 14, 15, 16, 18, 19, 20.

Briza encouraged by—

- (a) Starved or exhausted soils.
- (b) Nitrate of soda alone.

Briza killed out by—

- (a) Fair or good manuring of every kind.
- (b) Ammonium salts alone.

LIMED.

Increase caused by liming—

- 3 (unmanured) (from 2 to 9 per cent. in 1919).
- 4¹ (superphosphate).
- 8 (mins. without potash) (from 1.5 to 9 per cent. in 1914).

Decrease caused by liming—

- 2 (unmanured, after F.Y.M. for first 8 years).

SUMMARY.

Briza is in general an indicator of poverty or exhaustion of soil, and disappears when conditions are improved. It is often increased by liming.

Briza Media in Plant Communities.

When *Briza* occurs it is a constituent of the very varied associations characteristic of the poorer soils, but is rarely conspicuous except at flowering time. It does not appear to be specially associated with any particular group of species, except *Plantago* and *Leontodon*, which have much the same distribution.

BROMUS MOLLIS.

Absent from most plots. Very variable from year to year, hardly appearing at all in some seasons, as in 1919.

UNLIMED.

Plots on which quantity may be large (to 23 per cent.)—

14, 16 (mins. and nitrate of soda).

Plots on which an appreciable quantity may occur (to 5 per cent.)—

5² (mins., after amm. salts to 1897).

6, 7, 15 (mins. with potash).

19 (F.Y.M.).

20 (F.Y.M., mins., and sodium nitrate).

Plots on which traces may occur—

4¹ (amm. salts) (1903 only, not since).

5¹ (unmanured, after amm. salts to 1897).

8 (mins. without potash).

17 (nitrate of soda alone).

Plots from which entirely absent—

1, 2, 3, 4², 9, 10, 11¹, 11², 12, 13, 18.

Bromus encouraged by—

(a) Nitrate of soda and minerals.

(b) Minerals alone.

Bromus not encouraged or entirely suppressed by—

(a) Starved soils.

(b) Ammonium salts, with or without minerals.

(c) Organic manures applied frequently.

LIMED.

Plot on which liming may cause great increase—

7 (mins. only) (from 2 to 15 per cent. in 1914).

Plot on which liming may cause decrease—

16 (mins. and nitrate of soda) (from 8 to 3 per cent. in 1914).

Very few of the plots on which *Bromus* occurs have been limed, and it is impossible to draw any conclusion from the available figures as to the general effect of liming upon the species.

Bromus Mollis in Plant Communities.

Bromus is found with a varied selection of grasses, but a very close connection appears to exist with certain leguminous and miscellaneous plants. Constant association occurs as follows:—

- (a) Mixed minerals, limed or unlimed (plots 5², 6, 7, 15):
Bromus - *Lathyrus* - *Trifolium pratense* - *Centaurea-Achillea*.
- (b) Minerals and nitrate of soda (plot 14, 16): *Bromus-Lathyrus-Anthriscus-Taraxacum*.
- (c) Organic manures (plots 19, 20): *Bromus-Lathyrus-Centaurea-Achillea-Anthriscus*.

The close connection with *Lathyrus* is very marked, as where no *Bromus* occurs *Lathyrus* is either absent or very scanty. In view of the flora of plots 19 and 20, the paucity of *Bromus* on plot 13 (F.Y.M. and fish guano alternately) is noteworthy, but it is probable that the species was suppressed by the yearly application of ammonium salts till 1904, and has been unable to re-establish itself.

CYNOSURUS CRISTATUS.

Traces are present on several plots. The distribution and quantity have remained comparatively unchanged since 1877.

DACTYLIS GLOMERATA.

Occurs in samples on every plot, limed and unlimed.

UNLIMED.

Quantity large (over 30 per cent.)—

18 (mins. without super., and amm. salts).

Quantity fairly large (usually over 5 per cent.)—

1 (amm. salts).

5¹ (unman., after amm. salts to 1897).

6, 7 (mins. with potash).

13 (F.Y.M. and fish guano alternately).

16 (mins. and nitrate of soda).

17 (nitrate of soda).

19 (F.Y.M.).

20 (F.Y.M., mins., and sodium nitrate).

Quantity usually small (under 5 per cent.) *but variable.*

2, 3, 12 (unmanured).

4¹ (super.).

5² (mins., after amm. salts to 1897).

8 (mins. without potash).

9, 10 (mins. with and without potash, and amm. salts).

14 (mins. and heavy nitrate of soda).

15 (mins.).

Quantity usually very small (often under 1 per cent.)—

4² (super. and amm. salts).

11¹, 11² (mins. and heavy amm. salts, with and without silicates).

Dactylis encouraged by—

(a) Minerals and ammonium salts, in the absence of superphosphate.

(b) Nitrogenous manures alone.

(c) Organic manures

Dactylis not encouraged by—

(a) Starved soils.

(b) Absence of potash.

(c) Minerals with heavy dressings of nitrogenous manures.

LIMED.

Considerable increase in quantity (e.g. 0.5 to 11 per cent., 7 to 14 per cent., etc.)—

11¹, 11² (mins. and heavy amm. salts, with and without silicates).

Occasional considerable increase (e.g. 11 to 23 per cent., 10 to 15 per cent.)—

1 (amm. salts).

2 (unmanured).

Effect variable, not very marked—

3, 7, 8, 9, 10, 13, 16.

Some decrease in quantity—

4¹ (super.).

4² (super. and amm. salts).

Plots on which Dactylis was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	—	—	—	—	—
1914	—	6, 7, 16, 18	5 ¹ , 14, 19	—	—	1, 7, 11 ²
1919	2, 6, 7, 12, 18	4 ¹ , 16, 19, 20	3, 5 ¹ , 17	1, 7	2, 16	4 ¹ , 9, 11 ² , 13

* Returns incomplete.

SUMMARY.

Dactylis tends to be plentiful with most types of manuring, except those which bring about very acid or starvation conditions in the soil. It is comparatively little affected by liming, except where acidity is very marked.

Dactylis Glomerata in Plant Communities.

UNLIMED.

(a) *Festuca-Agrostis-Dactylis* is a very usual community, with other species associated according to the manuring.

(a) No manure or nitrogenous manure alone (plots 1, 2,

3, 12, 17) ; associations very mixed : *Anthoxanthum*, *Holcus*, *Avena pubescens*, *Briza media*, *Alopecurus*, *Plantago*, or *Centaurea* may be prevalent.

- (β) Minerals only (plots 6, 7, 15) : *Lathyrus*, and on plot 15 *Alopecurus*, associated.
- (γ) Occasional organic manures (plots 19, 20) : *Alopecurus* and *Lathyrus* associated.
- (δ) Heavy organic manure (plot 13) : *Alopecurus* and *Arrhenatherum* associated.
- (b) Ammonium salts and superphosphate (plot 4¹) : *Festuca-Dactylis-Holcus-Avena pubescens*.
- (c) Nitrate of soda and minerals (plot 16) : *Alopecurus-Dactylis-Lathyrus*; with *Bromus* and *Taraxacum*.

LIMED.

- (a) Unmanured (plot 2) : *Avena pubescens-Dactylis-Holcus-Festuca*.
- (b) Ammonium salts alone (plot 1) : *Festuca-Agrostis-Dactylis*, with several other species ; association very mixed.
- (c) Minerals with and without sodium nitrate (plots 7, 16) : *Alopecurus-Dactylis-Festuca*, with *Bromus*, *Lathyrus*, and *Avena pubescens*.
- (d) Heavy nitrogenous and mineral manuring or organic manures, in which acidity is not too pronounced (plots 9, 11², 13) : *Alopecurus-Arrhenatherum-Dactylis*, with *Festuca*, *Holcus*, or *Anthoxanthum*.

FESTUCA OVINA.

Occurs in samples from every plot, limed and unlimed.

UNLIMED.

Quantity large (usually over 40 per cent.)—

4² (super. and amm. salts).

5¹ (unmanured after amm. salts to 1897).

Quantity very variable with season, usually between 5 and 36 per cent.)—

2, 3, 12 (unmanured).

1 (amm. salts).

4¹ (super.).

5² (mins., after amm. salts to 1897).

6, 7, 8, 15 (mins. with and without potash).

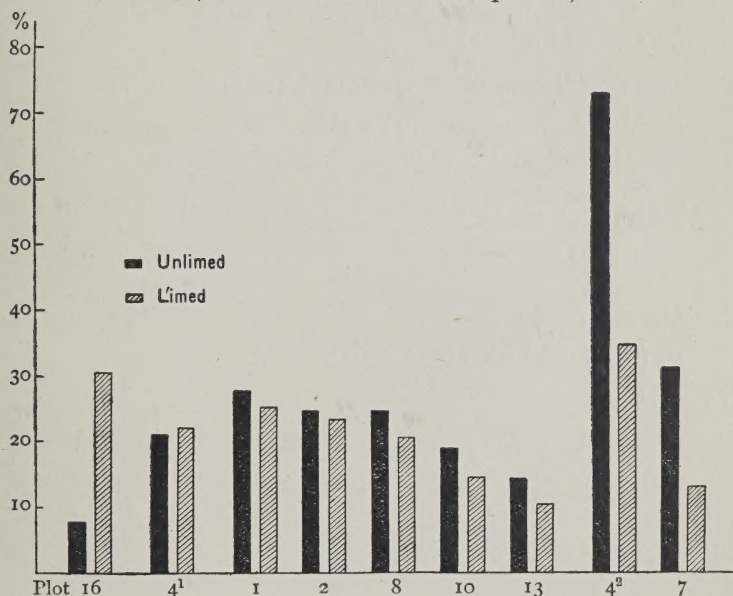


FIG. 14.—Percentage of *Festuca ovina* in herbage, 1914.

9, 10 (mins. with and without potash, and amm. salts).

13 (F.Y.M. and fish guano alternately).

17 (nitrate of soda) (less variable than most).

18 (mins. without super., and amm. salts).

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda).

Quantity small (usually 2-7 per cent.)—

14, 16 (mins. and nitrate of soda).

Quantity very small (under 1 per cent.)—

11¹, 11² (mins with and without silicates, and heavy amm. salts).

Festuca encouraged by—

- (a) Starved soils (in some seasons).
- (b) Minerals and by ordinary dressings of ammonium salts, whether singly or in combination.
- (c) Organic manures.

Festuca not encouraged or almost suppressed by—

- (a) Minerals and nitrate of soda.
- (b) Minerals and heavy dressings of ammonium salts.

Effect of season on this species is very marked.

LIMED.

Considerable increase—

16 (mins. and nitrate of soda).

No effect—

4¹ (super.).

11¹, 11² (mins. with and without silicates, and amm. salts).

Little effect or slight decrease—

1 (amm. salts).

2, 3 (unmanured).

8 (mins. without potash).

10 (mins. without potash, and amm. salts).

13 (F.Y.M. and fish guano alternately).

Great decrease in quantity—

4² (super. and amm. salts).

7 (mins. with potash).

Effect variable—

9 (mins. with potash, and amm. salts).

Plots on which Festuca ovina forms Largest Percentage of Graminaceæ.

TABLE A.

	Unlimed Plots.	Limed Plots.
1903*	4 ² , 7, 8	—
1914	1, 2, 3, 4 ¹ , 4 ² , 7, 8	1, 2, 3, 4 ¹ , 8
1919	4 ²	16

TABLE B.

	Unlimed Only.
1903*	5 ¹ , 6, 15, 17
1914	5 ¹ , 5 ² , 6, 12, 18, 19, 20
1919	5 ¹ , 5 ²

* Returns incomplete.

SUMMARY.

Festuca ovina is generally plentiful on the area, irrespective of the type of manuring, unless this is very heavy. It varies considerably in its response to liming, but is much more affected by seasonal variations.

***Festuca Ovina* * in Plant Communities.**

UNLIMED.

Festuca, in favourable seasons, is a dominant feature of the majority of the associations, and cannot be marked out as belonging to any particular one except *Festuca-Agrostis-Anthoxanthum*, characteristic of

* Under the old heading "*Festuca ovina*," which is retained for the sake of convenience, *Festuca duriuscula* and *F. rubra* are included and it is not easy to be certain whether any genuine *F. ovina* of modern nomenclature occurs or not. *F. duriuscula* is characterised by its downy sheath, *F. rubra* is very tufted and of more robust growth, but there is also present a form with smooth sheaths which may be *F. ovina* itself. When the leaves appear in the hay and are severed above the sheath, it is impossible to sort them out between the three species and all are therefore included under the one heading.

(a) Amm. salts and super. (plot 4²).

(b) Unmanured, after amm. salts (plot 5¹).

The occurrence of *Festuca* appears to have little relation to the general balance of the three main groups in the herbage, as it occurs as dominant where *Graminaceæ*, *Leguminosæ*, and *Miscellaneous* plants are well represented, and also where one or both of the latter groups are almost or entirely unrepresented.

With the coarse *Holcus-Arrhenatherum* grouping (on plots 11¹, 11²) *Festuca* is very scanty.

LIMED.

Associations very varied, as on unlimed.

Dominance of species reduced with amm. salts and super. (plot 4²).

FESTUCA PRATENSIS.

Rarely seen on any plots. Has much decreased, both in distribution and quantity.

HOLCUS LANATUS.

Occurs in samples from every unlimed plot except one, and from all the limed plots.

UNLIMED.

Quantity often very large (may reach 60-90 per cent.)—

11¹, 12² (mins. and heavy amm. salts).

Quantity medium (usually up to about 15 per cent.)—

1 (amm. salts).

2, 3 (unmanured).

4¹ (super.).

8 (mins. without potash).

13 (F.Y.M. and fish guano alternately).

17 (nitrate of soda).

20 (F.Y.M., mins., and nitrate of soda).

Quantity variable (from 1 to 13 per cent.)—

9, 10 (mins. with and without potash, and amm. salts).

Quantity usually small (under 5 per cent.)—

- 4² (super. and amm. salts).
 5¹ (unmanured, after amm. salts to 1897).
 5² (mins., after amm. salts to 1897).
 6, 7, 15 (mins.).
 12 (unmanured).
 16 (mins. and nitrate of soda).
 18 (mins. without super., and amm. salts).
 19 (F.Y.M.).

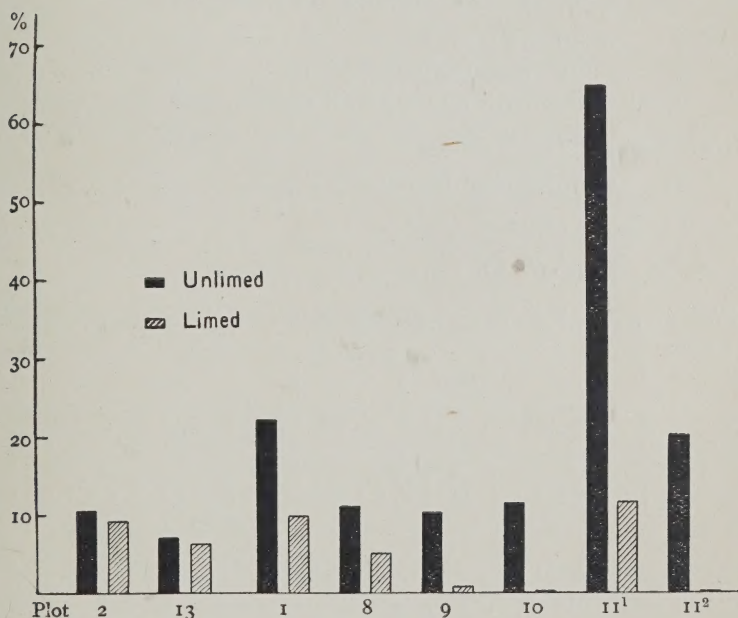


FIG. 15.—Percentage of *Holcus lanatus* in herbage, 1919.

Entirely suppressed—

- 14 (mins. and heavy nitrate of soda).

Holcus encouraged by—

- (a) Heavy dressings of ammonium salts and minerals.
 (b) Nitrogenous manures alone.
 (c) Omission of potash.

Holcus not encouraged by—

Mineral manures, alone or in combination with nitrogenous fertilisers other than heavy dressings of ammonium salts.

Holcus suppressed by—

Heavy nitrate of soda and minerals.

LIMED.

Considerable decrease due to liming in some seasons—

1 (amm. salts).

8 (mins. without potash).

9, 10 (mins. with and without potash, and amm. salts).

Great decrease due to liming—

11¹, 11² (mins. and heavy amm. salts).

No marked or constant effect—

2, 3, 4¹, 4², 7, 13, 16.

Plots on which Holcus was among the Three Dominant Grasses.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1914	11 ¹ , 11 ²	8	4 ¹ , 13, 20	11 ¹	—	2, 4 ¹ , 13
1919	1, 2, 3, 8, 11 ¹	17	4 ¹ , 9, 11 ²	—	4 ¹	1, 2, 3, 11 ¹

On plots with very high soil acidity and a good supply of plant nutrients (11¹, 11²) liming has caused a very great decrease, e.g. from 91 to 32 per cent., 59 to 6 per cent., 20 to .03 per cent., 65 to 12 per cent., etc.

Effect of liming is much less marked on plots with medium or low acidities.

SUMMARY.

Holcus lanatus appears to be a species that under ordinary conditions is kept in check by its associates, but tends to

become rampant and dominate the situation as soon as circumstances arise which are somewhat less favourable to the others. Over-nutrition, associated with soil acidity, gives the species great encouragement.

Holcus Lanatus in Plant Communities.

UNLIMED.

- (a) Ammonium salts (plot 1): *Festuca-Agrostis-Anthoxanthum-Dactylis-Holcus**-*Centaurea-Rumex*.
- (b) Ammonium salts and minerals (plots 9, 10): *Arrhenatherum-Anthoxanthum-Festuca-Holcus*, with *Agrostis*, *Alopecurus*, and *Rumex*.
- (c) Heavy ammonium salts and minerals (plots 11¹, 11²): *Holcus* - *Arrhenatherum*, or *Holcus* - *Arrhenatherum-Alopecurus*, forming an almost closed association.†

The other associations with which *Holcus* is connected are very varied as to species, and they also tend to vary from year to year with season.

LIMED.

- (a) Heavy ammonium salts and minerals (plots 11¹, 11²): *Alopecurus-Arrhenatherum-Holcus*. (On 11², with silicate of soda, *Holcus* almost disappears in some seasons.)

As on the unlimed plots, the other associations are varied and variable.

LOLIUM PERENNE.

Very small amounts or mere traces are present on most plots except those with mins. and amm. salts. Has much decreased, as it used to be present on most plots in fair quantity, reaching to over 7 per cent. in some cases.

* With ammonium salts and superphosphate the same association occurs *minus Holcus*.

† With nitrate of soda and minerals the *Arrhenatherum-Alopecurus* community is entirely free from *Holcus*.

POA PRATENSIS.

Present on all plots, generally in very small amount.

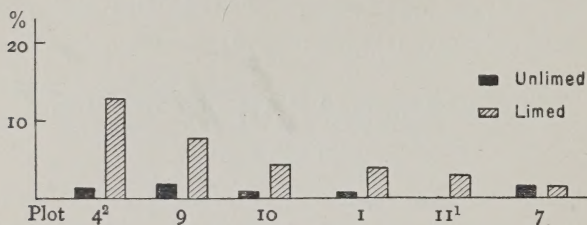


FIG. 16.—Percentage of *Poa pratensis* in herbage, 1914.

UNLIMED.

Quantity small (up to 6 per cent.)—

5² (mins., after amm. salts to 1897).

Usually under 2 per cent.—

All other plots.

LIMED.

Much increased—

4² (super. and amm. salts) (0.5 to 12 per cent.).

9, 10 (mins. and amm. salts) (1.5 to 7.5 per cent., etc.).

Some increase (0.5 to 3.5 per cent., etc.).

1 (amm. salts).

2, 3 (unmanured).

11¹, 11² (mins. and heavy amm. salts).

13 (F.Y.M. and fish guano).

Little or no effect—

4¹ (super.).

7, 8 (mins.).

16 (mins. and nitrate).

SUMMARY.

Poa pratensis is curiously tenacious of its position on the plots, considering the very small amounts that are usually present. It is not much affected by manuring, but is evidently impatient of acidity, as is shown by the

considerable increase brought about by liming, especially on the more acid plots.

Poa Pratensis in Plant Communities.

UNLIMED.

Is a more or less insignificant member of all associations.

LIMED.

- (a) Super. and amm. salts (plot 4²) : *Alopecurus-Poa pratensis-Festuca-Anthoxanthum*.
 (b) Mins. and amm. salts (plots 9, 10) : *Alopecurus-Arrhenatherum-Anthoxanthum-Festuca-Poa pratensis*, with or without *Dactylis*.

On all other plots *Poa* is a more or less insignificant member of the associations.

POA TRIVIALIS.

UNLIMED.

Usually present only in very small amounts, under 1 per cent.

Slightly encouraged (1.0-2.5 per cent.)—

4¹ (superphosphate).

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda).

Mere traces or entirely suppressed—

2, 3 (unmanured).

1, 4², 9, 10, 11¹, 11² (amm. salts, with or without mins.).

LIMED.

Slightly encouraged—

2, 3 (unmanured).

7 (mins.).

16 (mins. and sodium nitrate).

Poa Trivialis in Plant Communities.

A very insignificant member of all associations in which it occurs.

B. LEGUMINOSÆ.

LATHYRUS PRATENSIS.

Widely distributed, but absent from some plots, and present only in traces on several others.

UNLIMED.

Quantity sometimes large (up to 31 per cent.)—

6, 7, 15 (minerals).

16 (mins. and nitrate of soda).

Quantity medium (to 9 per cent.)—

8 (mins. without potash).

14 (mins. and heavy nitrate of soda)

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda).

Quantity very small (below 2 per cent.)—

2, 3, 12 (unmanured).

4¹ (super.).

5² (mins. after amm. salts to 1897).

13 (F.Y.M. and fish guano alternately).

Almost or entirely suppressed—

1 (amm. salts).

4² (super. and amm. salts).

5¹ (unman., after amm. salts to 1897).

9, 10, 11¹, 11² (mins. and amm. salts).

17 (nitrate of soda).

18 (mins. without super., and amm. salts).

Lathyrus encouraged by—

(a) Minerals, alone or with nitrate of soda.

(b) Occasional dressings of organic manure.

Lathyrus not encouraged by—

- (a) Starved soils.
- (b) Ammonium salts, alone or with minerals.
- (c) Nitrate of soda alone.
- (d) Frequent dressings of organic manures.

LIMED.*Considerable increase—*

- 4¹ (superphosphate).
- 7 (minerals).

Some increase—

- 2, 3 (unmanured).

No effect—

- 8 (mins. without potash).
- 13 (F.Y.M. and fish guano alternately).

Decrease in some seasons—

- 16 (mins. and nitrate of soda) (e.g. from 14 to 2 per cent. in 1914).

*Plots on which Lathyrus was among the Three Dominant
Species of the Whole Herbage.*

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	6, 7, 15	—	—	—	—	—
1914	15	6, 7, 16	—	7	—	4 ¹
1919	—	—	6, 7	7	—	—

* Returns incomplete.

SUMMARY.

Lathyrus is so much favoured by continued mineral manuring on this soil that it is sometimes one of the dominant species, growing in dense beds, which cover the ground and hinder the development of other plants. In most other cases very little is present. Effect of liming is variable, according to the manuring.

Lathyrus Pratensis in Plant Communities.**UNLIMED.**

- (a) Complete minerals or occasional dressings of organic manure (plots 6, 7, 15; 19, 20): *Festuca-Lathyrus-Dactylis-Agrostis*, often with *Avena pubescens*, *Holcus*, or *Alopecurus*.
- (b) Minerals without potash (plot 8): *Festuca-Holcus-Agrostis-Arrhenatherum-Lathyrus-Plantago*.
- (c) Minerals and nitrate of soda (plot 16): *Alopecurus-Dactylis-Lathyrus-Bromus-Taraxacum*.

LIMED.

- (a) Superphosphate (plot 4¹): *Avena pubescens-Festuca-Holcus-Lathyrus-Plantago-Centaurea*.
- (b) Complete minerals (plot 7): *Lathyrus-Dactylis-Alopecurus-Festuca-Bromus*.

N.B.—Cf. note on *Bromus mollis* as to the constant association of *Bromus* and *Lathyrus* throughout the plots.

LOTUS CORNICULATUS.

Low growing and late flowering, so may be more abundant in reality than appears from the analytical figures.*

Quantity relatively large (to 4 per cent.)—

2, 3, 12 (unmanured).

5² (mins., after amm. salts).

Quantity medium—

4¹ (super.).

6, 8 (mins. with and without potash).

Suppressed on—

1, 4², 9, 10, 11¹, 11² (amm. salts with and without mins.).

14, 16 (nitrate of soda and mins.).

13 (F.Y.M. and fish guano alternately).

A little occurs on all other plots—5¹, 7, 17, 19, 20.

* This species was very noticeable in August, 1921, after the prolonged drought, as the leaves were very green and the plants were flowering profusely.

Lotus encouraged by—

- (a) Starved soils.
- (b) Minerals.

Lotus suppressed by—

- (a) Nitrogenous manures with minerals.
- (b) Frequent organic manuring.

LIMED.

Very little effect, except for

Slight increase—

4¹ (superphosphate).

Lotus Corniculatus in Plant Communities.

Lotus is not usually a significant member of the plant communities, though it is rather conspicuous in the very mixed association of unmanured soils.

ONONIS ARVENSIS.

Occurs in small quantity on plot 4¹ (superphosphate).

TRIFOLIUM PRATENSE.

Rather low growing, and consequently does not always appear in representative quantity in the samples, especially when the season is unfavourable for growth.

UNLIMED.

Quantity relatively large (to 5.3 per cent.)—

6, 7, 8 (mins. only).

Quantity medium (to 2.5 per cent.)—

3, 12 (unmanured).

4¹ (superphosphate).

5² (mins., after amm. salts).

15 (minerals).

Quantity very small—

- 5¹ (unman., after amm. salts to 1897).
 16 (mins. and light dressings of nitrate of soda).
 17 (nitrate of soda).
 19 (F.Y.M.).

Suppressed—

- 1, 4², 9, 10, 11¹, 11², 18 (amm. salts with and without minerals).
 13 (F.Y.M. and fish guano alternately).
 14 (heavy nitrate of soda and mins).
 20 (F.Y.M., mins., and sodium nitrate).

Trifolium pratense encouraged by—

- (a) Minerals.
 (b) Starved soils.

Trifolium pratense suppressed by—

- (a) Ammonium salts.
 (b) Heavy organic manures.
 (c) Heavy dressings of sodium nitrate.

LIMED.

Effect variable; quantity usually increased, especially with minerals.

Trifolium Pratense in Plant Communities.

Rarely present in sufficient quantity to be a significant member of the associations, except with minerals only (plots 6, 7, 8, unlimed), where *Festuca-Agrostis-Lathyrus-Rumex* occur with *Dactylis*, *Holcus*, *Avena pubescens*, *Arrhenatherum*, and *Plantago* associated on different plots.

TRIFOLIUM REPENS.

Very low growing and rather late in development, and in consequence does not always appear in representative quantity in the samples.

Quantity relatively large (to 2.4 per cent.)—

7, 15 (minerals only).

Suppressed—

1, 4², 9, 10, 11¹, 11², 18 (amm. salts with and without mins.).

5¹ (unmanured, after amm. salts to 1897).

13 (F.Y.M. and fish guano alternately).

14, 17 (nitrate of soda with and without mins.).

Occurs in small amount on all other plots.

LIMING.

Effect uncertain : data insufficient.

VICIA SEPIUM.

Occurs in small quantity on plots 6, 7 (minerals).

C. MISCELLANEOUS SPECIES.

AJUGA REPTANS.

Traces on most plots, except those receiving nitrogenous manures.

ACHILLEA MILLEFOLIUM.

UNLIMED.

Quantity fairly large (to 6 per cent.)—

6, 7, 8, 15 (minerals)

Suppressed on—

4², 9, 10, 11¹, 11² (amm. salts and mins.).

Present in small amount (up to 3 per cent.) on all other plots.

Achillea encouraged by—

(a) Minerals.

Achillea discouraged by—

(a) Ammonium salts.

LIMED.

Effect of liming variable.

ANTHRISCUS SYLVESTRIS.

Encouraged by—

Nitrate of soda (plots 14, 16, 17), to 2.4 per cent.

Organic manures (plots 13, 19, 20), to 3 per cent.

Traces with—

Minerals (plots 5², 7, 15).

Absent from other plots.

CAREX PRÆCOX.

3, 12 (unmanured). In appreciable quantity, to 1·8 per cent.

2, 4¹, 7, 8, 16, 17, 18. Traces.

CENTAUREA NIGRA.

UNLIMED.

Quantity may be large (to 19 per cent.)—

1 (amm. salts).

Quantity usually medium (to 9 per cent.)—

2, 3, 5¹, 12 (unmanured).

4¹ (superphosphate).

5² (mins., after amm. salts to 1897).

6, 7, 8, 15 (mins., with or without potash).

17 (nitrate of soda alone).

18 (mins. without super., and amm. salts).

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda).

Almost or entirely suppressed—

4² (super. and amm. salts).

9, 10, 11¹, 11² (mins. and amm. salts).

13 (F.Y.M. and fish guano).

14, 16 (mins. and nitrate of soda).

Centaurea encouraged by—

(a) Starved soils.

(b) Nitrogenous manures or mineral manures alone

(c) Occasional dressings of organic manures.

Centaurea almost or entirely suppressed by—

(a) Nitrogenous and mineral manures applied together.

(b) Frequent dressings of organic manures.

LIMED.

Increase—

1 (amm. salts alone).

Decrease—

7 (mins. only).

Little or no effect—

2, 3, 4¹, 8, 13, 16.

Plots on which Centaurea was among the Three Dominant Species of the Whole Herbage.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	—	—	—	—	—
1914	—	1, 8	5 ²	—	1, 8	3
1919	—	—	—	—	—	—

* Returns incomplete.

SUMMARY.

Centaurea is encouraged by one-sided manuring, whether nitrogenous or mineral, but is crowded out completely when both are applied together. Liming does not usually have a very marked effect.

Centaurea Nigra in Plant Communities.

Centaurea is a member of most of the very mixed associations found on soils that are starved or treated with various one-sided manures. It is seldom a constituent of the smaller, more clearly-marked associations, except with—

Amm. salts alone (plot 1) : *Festuca-Agrostis-Anthoxanthum-Dactylis-Holcus-Centaurea*.

CERASTIUM VULGATUM.

Occurs in small amount, except on those plots receiving minerals with ammonium salts or nitrate of soda.

LIMING.

Causes increase.

CONOPODIUM DENUDATUM.

Very variable with season ; in some years it does not reach 1 per cent. in any samples ; in others, it may run up to over 10 per cent. on certain plots. Flowers early, and often dies down before hay-time, so is really more abundant in herbage than is indicated by percentage figures.

UNLIMED.

Medium quantity sometimes present (over 4 per cent.)—

2, 3, 12 (unmanured).

6, 7 (minerals).

18 (mins. without super., and amm. salts).

Quantity small—

8, 13, 15, 17, 19, 20.

Very little present (usually under 0.5 per cent.)—

1, 4¹ (amm. salts, with and without super.).

5¹ (unmanured, after amm. salts).

16 (mins. and nitrate of soda).

Almost or entirely suppressed—

4², 9, 10, 11¹, 11² (mins. and amm. salts).

5² (mins., after amm. salts to 1897).

Conopodium encouraged by—

(a) Starved soils.

(b) Minerals.

Conopodium suppressed by—

(a) Ammonium salts.

LIMED.

Considerably reduced, except on—

16 (mins. and nitrate). Increase.

1, 4¹, 13 No effect.

Conopodium Denudatum in Plant Communities.

Occasionally a conspicuous element of the varied associations on the unmanured and mineral plots.

GALIUM VERUM.

Is present in some seasons in very small quantities on most plots, except those receiving complete manures, whether artificial or organic.

HERACLEUM SPHONDYLIIUM.

7 (mins.). Occasionally rather plentiful (to 4 per cent.).

Occurs casually in some seasons in very small quantities on most plots, except those receiving no manure or minerals with amm. salts or nitrate of soda. Is increasing in amount.

Effect of liming uncertain owing to lack of sufficient data.

HIERACIUM PILOSELLA.

Traces only occur on plots with no manure, or minerals after amm. salts to 1897.

LEONTODON HISPIDUS.

Present on few plots.

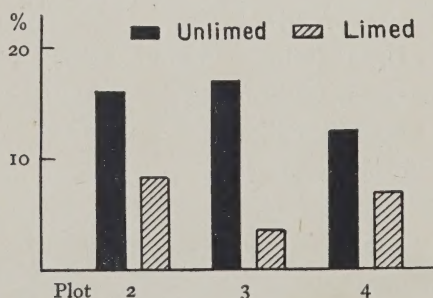


FIG. 17.—Percentage of *Leontodon hispidus* in herbage, 1914.

UNLIMED.

Quantity may be fairly large (up to 17 per cent., usually nearer 5 per cent.)—

- 2, 3, 12 (unmanured).
 4¹ (superphosphate).
 17 (nitrate of soda alone).

Quantity very small—

8 (mins., without potash).

Occasional traces—

5¹, 5² (unmanured, and mins., after amm. salts to 1897).

Absent from all other plots.

Leontodon encouraged by—

- (a) Starved or exhausted soils.
 (b) Nitrate of soda alone.

Leontodon not encouraged by—

- (a) All forms of good or medium manuring.

LIMED.

Considerable decrease usually—

- 2, 3 (unmanured).
 4¹ (super.).

Plots on which Leontodon was among the Three Dominant Species of the Whole Herbage.

	Unlimed.	Limed.
	Second.	Third.
1914 only	2, 3, 4 ¹	2

Leontodon Hispidus in Plant Communities.

UNLIMED.

Characteristic association on plots 2, 3, 4¹, 12, 17 is *Festuca-Agrostis-Dactylis-Avena pubescens-Holcus-Anthoxanthum-Briza-Lotus-Leontodon-Centaurea-Plantago*.

N.B.—Little *Agrostis* on plot 4¹, and much *Alopecurus* on plot 17.

LIMED.

Plots 2, 3, 4¹: *Festuca-Dactylis-Avena pubescens-Holcus-Briza-Leontodon-Plantago-Centaurea*.

LUZULA CAMPESTRIS.

Relatively plentiful on plot 5² (mins. after amm. salts to 1897), where it may reach over 4 per cent. Plot is pink with it in spring at flowering-time.

Present in small amount (under 0.5 per cent.) on all other plots, except those receiving mins. with amm. salts or nitrate of soda.

PIMPINELLA SAXIFRAGA.

Very late in developing, and does not usually flower till after hay-time. Is only represented in very small quantity in the samples from the unmanured and mineral plots, but is more abundant later in the year than the analytical figures indicate.

Probably slightly increased by liming.

PLANTAGO LANCEOLATA.

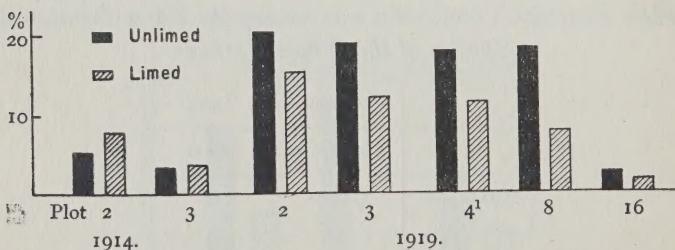


FIG. 18.—Percentage of *Plantago lanceolata* in herbage, showing variable effect of liming on some plots in different seasons.

UNLIMED.

Quantity often large (may reach 24 per cent.)—

- 2, 3, 12 (unmanured).
- 4¹ (superphosphate).
- 8 (mins., without potash).
- 17 (nitrate of soda).

Quantity small (up to 4 per cent.)—

15 (mins.).

16 (mins. and nitrate of soda).

Quantity very small (usually 1 per cent. or under)—

5¹ (unmanured after amm. salts).

5² (mins., after amm. salts).

6, 7 (mins.).

19 (F.Y.M.).

20 (F.Y.M., mins., and nitrate of soda)

Absent from plots—

1, 4², 9, 10, 11¹, 11², 13, 14, 18.

Plantago encouraged by—

(a) Starved or exhausted soils.

(b) Nitrate of soda alone.

Plantago entirely suppressed by—

(a) Ammonium salts, with or without minerals.

(b) Heavy nitrate of soda and minerals.

(c) F.Y.M. and fish guano.

LIMED.

Decrease due to liming—

4¹ (superphosphate).

7, 8 (mins.).

16 (mins. and nitrate of soda).

Effect of liming variable—

2, 3 (unmanured) (increase 1914, decrease 1919).

Plots on which Plantago was among the Three Dominant Species of the Whole Herbage.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	—	—	—	—	—
1914	—	—	8, 17	—	—	—
1919	2, 3, 4 ¹ , 8, 17	—	—	—	2, 3, 4 ¹	8

* Returns incomplete.

SUMMARY.

Plantago seems to be chiefly associated with poor or exhausted soils, and in some seasons is very plentiful. It is usually decreased by liming.

Plantago Lanceolata in Plant Communities.

Plantago is usually a more or less conspicuous member of the varied associations characteristic of the poorer soils. When present in any quantity it appears to have a close connection with *Briza* and *Leontodon*.

POTERIUM SANGUISORBA.

Large clumps present on limed and unlimed halves of unmanured and superphosphate plots (2, 3, 4¹). On plot 3 (unlimed) it sometimes forms nearly 6 per cent. of the herbage.

As *Poterium* is usually regarded as a lime-lover, its presence in such quantity on the unlimed plots is somewhat remarkable.

PRIMULA VERIS.

2, 3, 12 (unmanured). In fair amount, especially on 12.

4¹, 7, 8, 15 (minerals). Few clumps.
Occasional traces on plots 13, 19.

This species is seldom represented in the samples owing to its earliness and low habit of growth.

RANUNCULUS ACRIS ET BULBOSUS.

Occur in small amount on several plots.

Encouraged by—

(a) Minerals (4¹, 6, 7, 8, 15).

(b) F.Y.M. (19, 20).

Suppressed by—

Amm. salts (4², 9, 10, 11¹, 11², 18).

LIMING.

Causes increase in nearly every case. Occasionally effect is less marked in certain seasons.

RUMEX ACETOSA.

Very dependent on season. In unfavourable years (as 1914) growth is not sufficiently high to admit of much of the plant being cut by the machine at hay-time. Estimates, therefore, are made chiefly from 1919 figures.

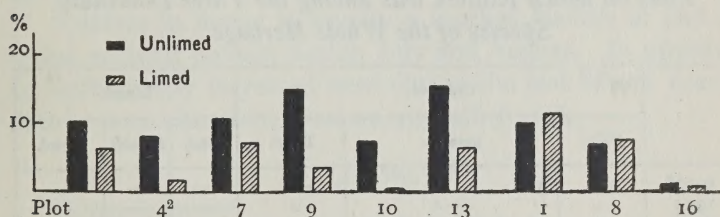


FIG. 19.—Percentage of *Rumex acetosa* in herbage, 1919.

UNLIMED.

Quantity may be large (up to 15-24 per cent.)—

- 1, 4², 9, 10, 18 (amm. salts, with or without mins.).
- 4¹ (superphosphate).
- 5¹, 5² (unmanured, or mins. after amm. salts to 1897).
- 6, 7, 8, 15 (mins.).
- 13 (F.Y.M. and fish guano).
- 19 (F.Y.M.).

Quantity small—

- 2, 3, 12 (unmanured).
- 14, 16, 17 (sodium nitrate, with and without mins.).
- 20 (F.Y.M., mins., and sodium nitrate).

Almost suppressed—

- 11¹, 11² (mins. and heavy amm. salts)

Rumex encouraged by—

- (a) Minerals.
- (b) Ammonium salts.
- (c) Organic manures.

Rumex not encouraged by—

- (a) Starved soils.
- (b) Sodium nitrate.
- (c) Heavy nitrogenous manuring.

Plots on which Rumex was among the Three Dominant Species of the Whole Herbage.

	Unlimed.			Limed.		
	First.	Second.	Third.	First.	Second.	Third.
1903*	—	5 ¹	—	—	—	—
1914	—	—	—	—	—	—
1919	—	5 ¹ , 5 ² , 6, 7, 9, 18, 19	4 ² , 13, 15	—	1	8

* Returns incomplete.

LIMED.*Possible increase—*

2, 3 (unmanured).

Decrease—

4¹ (superphosphate).

4², 9, 10 (mins. and amm. salts).

7 (mins.).

13 (F.Y.M. and fish guano).

No effect—

1, 8, 16.

SUMMARY.

Rumex appears to be encouraged in certain years by soil acidity, but is suppressed when this is extreme, as with very heavy manuring with ammonium salts. Liming usually decreases the quantity where acid conditions prevail.

Rumex Acetosa in Plant Communities.

Occurs in a great variety of associations, of which *Festuca* is always a prominent member when *Rumex* is at all prevalent. The association with other species is less constant.

SCABIOSA ARVENSIS.

Flowers late, so is more obvious in the aftermath than in the hay samples.

Chiefly found with no manure (2, 3, 12, 5¹) and with minerals (5², 6, 7, 8); usually absent elsewhere.

Scabiosa in flower is usually a marked feature of plot 8 (mins. without potash) during July and August. It appears to have greatly increased here during the last fifteen years, and is more abundant than on any other plot.

LIMING.

Causes increase.

STELLARIA GRAMINEA.

In very small quantity on most plots, except those receiving ammonium salts.

LIMING.

Causes slight increase. Species occurs relatively plentifully with amm. salts alone (plot 1), though it is absent from the unlimed part of the plot.

TARAXACUM VULGARE.

Flowers early and dies down, so is more abundant where it occurs than analytical figures indicate.

14, 16 (nitrate and mins.). Characteristic and plentiful (to 7 per cent.).

7, 15 (mins.). Occasionally in fair quantity to 1.3 (per cent.).

2, 3, 6, 17, 19, 20. Very small amounts in samples.

Occasional traces on a few other plots.

LIMING.

Possibly causes reduction.

TRAGOPOGON PRATENSIS.

In some seasons traces occur on several plots, chiefly on unmanured and minerals.

VERONICA CHAMÆDRYS.

Very small quantities on—

2, 3, 5¹, 12 (unmanured).

4¹, 5², 6, 8 (mins.).

17 (sodium nitrate).

19, 20 (F.Y.M. with or without mins.).

Miscellaneous Plants which are usually Present only in
Traces or Very Small Amount.

Species.	Plots.	Remarks.
<i>Agrimonia eupatoria</i> .	2, 3, 4 ¹ , 6, 8, 16, 20	Noticeable on 8 in after-math.
<i>Alchemilla vulgaris</i> .	2	Not in samples (*).
<i>Bellis perennis</i> .	12, 13	Not in samples.
<i>Cardamine pratensis</i> .	19	Rarely in samples.
<i>Chrysanthemum leucanthemum</i> . . .	3	Not in samples.
<i>Epilobium</i> sp. . . .	5 ²	A rare casual.
<i>Fritillaria meleagris</i> .	17	Not in samples.
<i>Hypochaeris radicata</i> .	5 ¹ , 5 ² , 12	Occasionally in samples.
<i>Linum catharticum</i> .	1	Not in samples.
<i>Ophioglossum vulgatum</i> .	2, 3, 17	Rarely in samples.
<i>Potentilla fragariastrum</i> .	2, 12, 20	Not in samples.
" <i>reptans</i> . . .	1, 2, 3, 8, 9, 10, 16, 17	Rarely in samples.
<i>Prunella vulgaris</i> . . .	3, 4 ¹ , 8, 12, 13, 19, 20	Seldom in samples.
<i>Scilla non-scripta</i> . . .	19, 20	Not in samples.
<i>Senecio jacobea</i> . . .	17	A rare casual.
<i>Spiraea ulmaria</i> . . .	1, 6, 7, 8	Situation unusual, large clumps.
<i>Thymus serpyllum</i> . . .	3, 12, 16	Not in samples.
<i>Viola canina</i>	16, 17, 20	Rarely in samples.

* "Not in samples" indicates that even though a leaf or two might occur there was not sufficient to weigh to include in percentage figures.

CHAPTER V.

SUMMARY.

A. GENERAL EFFECT OF INDIVIDUAL AND COMBINED MANURES ON UNLIMED PLOTS.

I. ON YIELD AND GROWTH OF CROP.

ALL the manures tested give an increase of crop over no manure in most years, though the degree of improvement varies greatly with the different combinations.

Nitrogenous Manures Alone.—Nitrate of soda gives an appreciable increase of yield, but ammonium sulphate is less successful, and in some seasons the crop falls below that from the unmanured plots. The growth of herbage is not altogether satisfactory in either case.

Mineral Manures Alone.—The increase with complete minerals is very considerable, the crop being on an average two to three times that from the unmanured plots. In the absence of potash, however, a heavy drop occurs to about two-thirds of the crop with complete minerals. The growth of the herbage is usually normal and good.

Nitrogenous and Mineral Manures Combined.—Very heavy yields are obtained with both nitrate of soda and ammonium sulphate, as much as three tons per acre being reached in some seasons. Nitrate of soda pushes up the yield the more rapidly, as a double dressing (= 86 lbs. N. per acre) often gives as heavy a crop as a triple dressing (= 129 lbs. N. per acre) of ammonium salts.

The growth of the herbage is very rank, and tends to become coarse and hard on occasion, especially with heavy

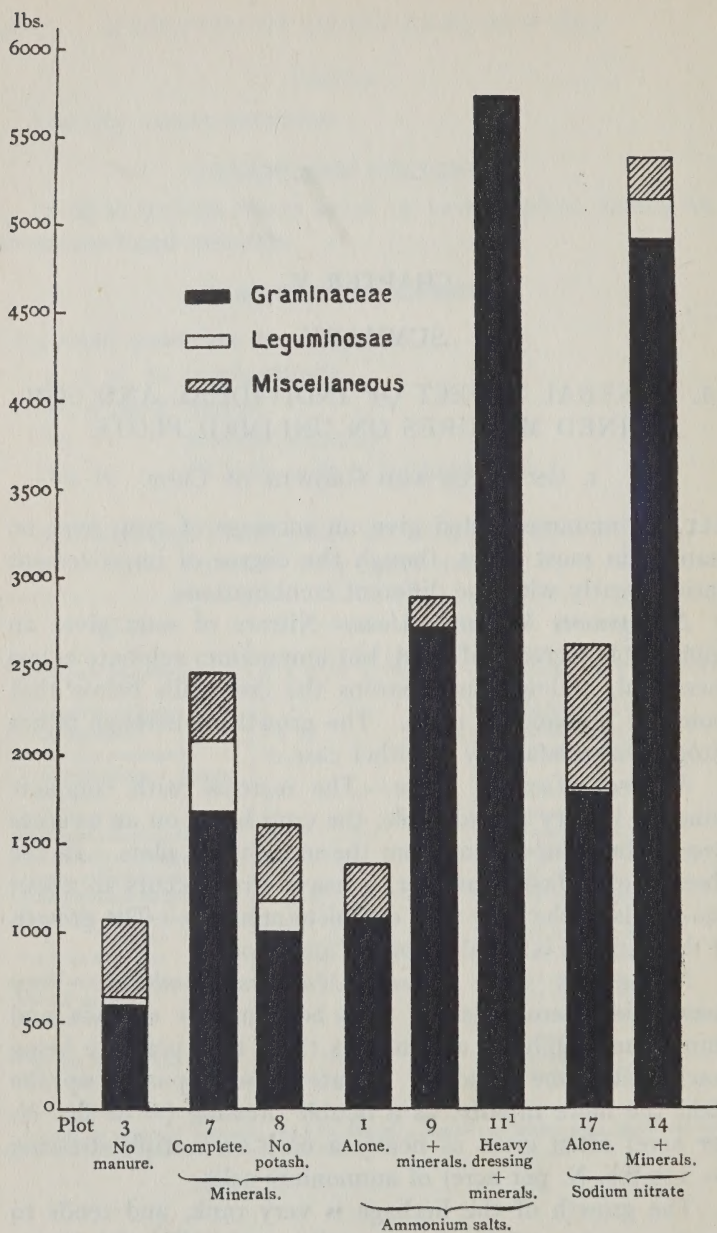


FIG. 20.—Showing comparative effect of various Manures on Total Produce per acre and upon the Proportions of *Graminaceae*, *Leguminosae* and *Miscellaneous* Species for the year 1914.

dressings of ammonium sulphate. It is very liable to lodge, and gives much trouble at harvest-time.

Organic Manures.—These increase the yield and generally help the grass to get away earlier in the spring than where artificials are used alone. The type of herbage, however, is much influenced by the other fertilisers applied.

2. ON NUMBER OF SPECIES.

In the absence of manure, thirty to forty species are present, subject to considerable seasonal fluctuations. As the applications of manure, especially of a nitrogenous character, become successively heavier, the number of species decreases until with large dressings of ammonium sulphate only about eight to ten species survive, and of these only two or three are significant in quantity. Mineral manures are much less effective than nitrogenous fertilisers in reducing the number of species.

3. ON RELATIVE AMOUNTS OF GROUPS OF HERBAGE.

Nitrogenous Manures.—An almost complete elimination of *Leguminosæ* is effected by ammonium salts, whether with

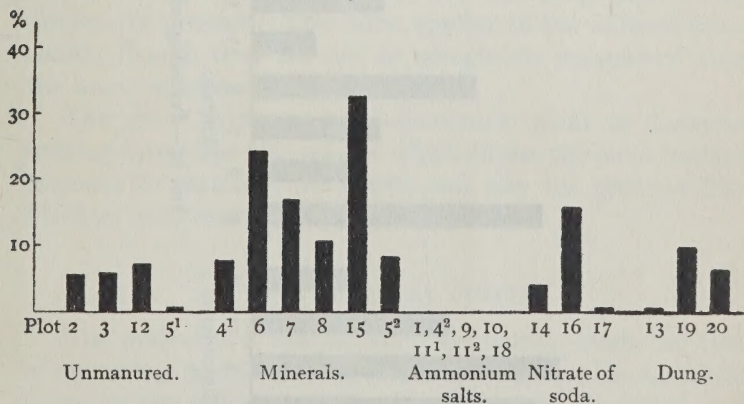
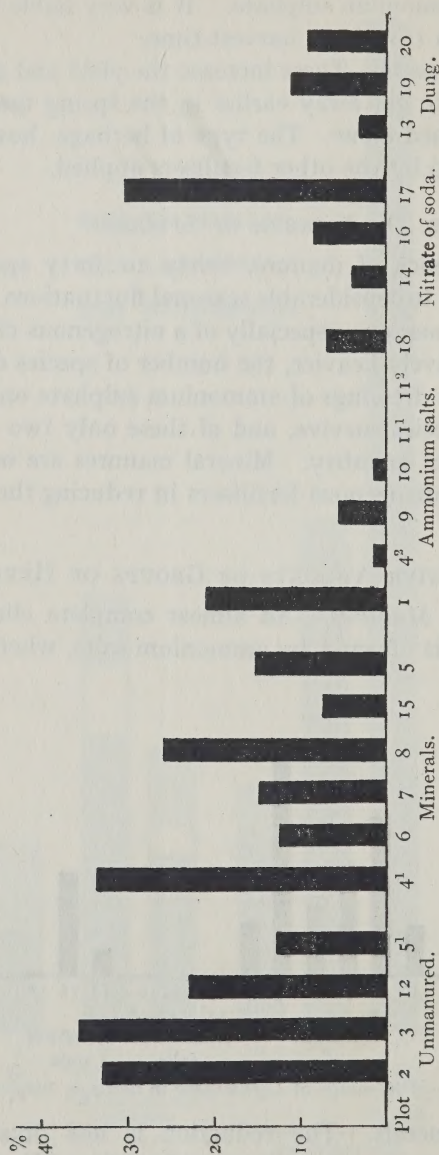


FIG. 21.—Percentage of *Leguminosæ* in herbage, 1914.

or without minerals. The reduction is less drastic with nitrate of soda, though still considerable. *Miscellaneous*

FIG. 22.—Percentage of *Miscellaneous* Species in herbage, 1914.

species are prevalent in the latter case, and less so with ammonium salts, but the addition of minerals and increase in the dressings of nitrogen applied cause steady reduction, until the herbage consists of little but grasses where heavy manuring is carried out.

Mineral Manures.—All three groups are well represented. Strong encouragement is afforded to leguminous plants, which sometimes constitute one-third of the herbage under these conditions.

In the absence of potash, however, the increase is usually less strongly marked. It is noticeable that in the presence of nitrogenous manures, especially ammonium salts, the encouraging action of the mineral manure is entirely masked by the inhibition exercised by the nitrogenous manure.

Farmyard manure probably encourages *Leguminosæ* to some extent if used alone, but in combination with artificial fertilisers it is the nature of the latter which is the determining factor. Thus when farmyard manure is used after prolonged treatment with ammonium salts *Leguminosæ* are almost or entirely absent, whereas in combination with nitrate of soda and minerals a very fair proportion of the species are present. The same applies to the *Miscellaneous* plants, though they are not so completely suppressed after the ammonium salts.

The most conspicuous leguminous plant is *Lathyrus pratensis*, and it is this species which shows the most marked response to manurial treatment and also the greatest fluctuations with season.

4. ON INDIVIDUAL SPECIES.

The majority of species vary in quantity with the type of manuring, but it is often uncertain whether the variation is due to the influence of the manure or soil conditions and the consequent effect upon the nutrition of the species concerned, or whether it is rather a matter of lessened or increased competition of other plants. Many species like

Agrostis, *Plantago*, *Leontodon*, *Conopodium*, *Briza*, and *Lotus*, which are conspicuous on poor or starved soil, disappear more or less completely in most cases with artificial manuring. *Festuca ovina* is much encouraged by ammonium salts alone, but the addition of minerals brings to the fore *Holcus*, *Anthoxanthum*, and *Arrhenatherum*.

The difference in the action of ammonium salts and nitrate is well shown by the prevalent species, for in the latter case *Holcus* is entirely suppressed (instead of being dominant), and *Alopecurus*, *Avena pubescens*, and *Bromus* are the conspicuous features. Minerals, again, afford encouragement to *Avena pubescens*, *Lathyrus*, *Centaurea*, *Lotus*, *Trifolium pratense*, and *Bromus*, some of which, it will be noticed, are also particularly associated with other types of manuring.

Generally speaking, with moderate or no manuring many species retain their footing even though they may be much reduced in quantity. With excessive manuring, on the other hand, a large number of species tend to disappear entirely, and one or two others to increase to such an extent that they are the outstanding feature, to the serious detriment of the balance of the composition of the herbage.

B. GENERAL EFFECT OF LIMING.

I. ON YIELD AND GROWTH OF CROP.

Liming has increased the yield in all cases with ammonium salts and minerals, and also with complete minerals alone. Where, however, incomplete mineral manures or nitrate of soda have been applied, there has been a considerable reduction of crop. A similar reduction occurs with frequent dressings of farmyard manure and fish guano, but in the absence of manure and with ammonium salts alone lime has no constant effect at the present time, though in the first years after 1903 an improvement was noticed, but this was not maintained.

2. ON NUMBER OF SPECIES.

Liming has no constant effect upon the number of species in most cases, though an increase is to be observed with ammonium salts alone and with heavy ammonium salts and minerals.

3. ON RELATIVE AMOUNTS OF GROUPS OF HERBAGE.

Graminaceæ are usually more or less increased by liming, except with ammonium salts only, where a decrease occurs which is very considerable in some seasons, reaching 9 per cent. in 1919.

Leguminosæ are affected in a variable manner. With superphosphate and with complete minerals a relatively heavy increase occurs (6 per cent., 11 per cent., etc.), whereas with minerals without potash, and with nitrate of soda plus minerals a corresponding decrease is evident (2.5 per cent., 13 per cent., etc.).

Miscellaneous plants are decreased, often considerably, with all manures except ammonium salts alone, in which case an increase (to 8 per cent.) occurs.

4. ON INDIVIDUAL SPECIES.

On the whole, the effect of liming is more marked on the plots receiving nitrogenous and mineral manure than on those with minerals only or no manure. *Alopecurus* shows the most extraordinary response to liming where the manuring is good and soil conditions tend towards acidity, while *Holcus* and *Anthoxanthum* show a similar but less striking decrease. *Lathyrus*, *Avena pubescens*, and *Poa pratensis* are all usually favoured by liming; *Agrostis*, *Plantago*, *Rumex*, and *Conopodium* generally exhibit reduction, and the other more important species vary considerably in their behaviour according to the manure applied.

C. EFFECT OF SILICATE OF SODA.

Silicate of soda applied in conjunction with heavy ammonium salts and minerals has a very similar effect to lime. The yield with silicates is often greater than that with lime, and the relative percentages of the characteristic plants *Holcus*, *Alopecurus*, and *Arrhenatherum* are influenced in the same direction by both the alkalis, though the change does not go quite so far with silicates. The beneficial action of the latter substance is probably to be attributed to its alkalinity, which acts, like lime, in reducing the high acidity induced by the heavy ammonium manuring.

TABLE I.

Quantity of Manure per Acre.											Average Produce of Hay per Acre over the Six Successive 10-year Periods, 1856-1915, and over the 5-year Period, 1916-1920. First Crops only.								
Plot.	Description of Manure.	Nitrogenous Manures.			Mineral Manures.				Organic Manures.		Plot.	Averages Over							
		Ammonium Sulphate.	Nitrate of Soda.	Superphosphate, 37 per cent.	Sulphate of Potash.	Sulphate of Soda.	Sulphate of Magnesia.	Silicate of Soda.	Dung.	Fish Guano.		10 years, 1856-65.	10 years, 1866-75.	10 years, 1876-85.	10 years, 1886-95.	10 years, 1896-1905.	10 years, 1906-15.	5 years, 1916-20.	
		Lbs.	Lbs.	Cwts.	Lbs.	Lbs.	Lbs.	Lbs.	Ton.	Cwt.		Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.	
1	Ammonium salts (= 43 lbs. N) (with dung 8 years, 1856-63)	220	—	—	—	—	—	—	—	—	1	48.4	37.8	30.1	23.8	19.3	18.9	13.3	
2	Unmanured (after dung 8 years, 1856-63)	—	—	—	—	—	—	—	—	—	2	41.7	32.1	22.0	20.5	15.1	14.2	13.1	
3	Unmanured	—	—	—	—	—	—	—	—	—	3	22.6	20.0	17.5	16.8	13.2	10.9	10.4	
4(1)	Superphosphate of lime	—	—	3.5	—	—	—	—	—	—	4(1)	24.4	21.3	19.1	16.5	15.7	16.8	18.8	
4(2)	Superphosphate and ammonium salts (= 86 lbs. N)	440	—	3.5	—	—	—	—	—	—	4(2)	39.6	30.5	30.4	29.0	26.8	22.5	15.1	
5(1)	(N. half) Unmanured (after ammonium salts, 1856-97 = Plot 5)	—	—	—	—	—	—	—	—	—	5	30.5	22.1	17.6	17.5	—	—	—	
5(1)		—	—	—	—	—	—	—	—	—	5(1)	—	—	—	—	14.4 ⁸	10.2	8.5	
5(2)	(S. half) Superphosphate, sulphate of potash (after ammonium salts, 1856-97 = Plot 5)	—	—	3.5	500	—	—	—	—	—	5(2)	—	—	—	—	24.2 ⁸	17.2	19.0	
6	As plot 7 (after ammonium salts, 1856-68)	—	—	3.5	500	100	100	—	—	—	6	31.4	30.2	30.5	29.0	34.9	29.5	30.0	
7	Complete mineral manure	—	—	3.5	500	100	100	—	—	—	7	33.9	36.8	32.3	27.1	30.1	30.0	27.6	
8	Mineral manure without potash	—	—	3.5	—	100	100	—	—	—	8	33.6	26.6	21.8	16.5	21.3	19.3	16.5	
9	Complete mineral manure and ammonium salts (= 86 lbs. N)	440	—	3.5	500	100	100	—	—	—	9	53.6	48.4	50.5	39.3	44.1	36.8	34.3	
10	Mineral manure (without potash) and ammonium salts (= 86 lbs. N)	440	—	3.5	—	100	100	—	—	—	10	52.8	39.6	38.6	35.5	34.6	25.6	22.2	
11(1)	Complete mineral manure and extra ammonium salts (= 129 lbs. N)	660	—	3.5	500	100	100	—	—	—	11(1)	61.7	53.6	48.5	47.6	57.8	45.9	36.2	
11(2)	As plot 11(1), and silicate of soda	660	—	3.5	500	100	100	400	—	—	11(2)	66.4 ³	61.7	60.6	62.0	57.1	56.8	45.2	
12	Unmanured	—	—	—	—	—	—	—	—	—	12	25.1	22.9	18.0	17.1	17.6	14.0	12.3	
13	Dung and fish guano, each once in four years since 1905 (after cut wheat straw, minerals, and ammonium salts)	—	—	—	—	—	—	—	14	6	13	55.1	57.6	54.2	49.1	47.0 ⁷	32.1 ⁴	37.1	
14	Complete mineral manure and nitrate of soda (= 86 lbs. N)	—	550	3.5	500	100	100	—	—	—	14	53.1 ²	60.5	53.8	45.6	50.0	47.7	53.7	
15	Complete mineral manure (after nitrate of soda, 1858-75)	—	—	3.5	500	100	100	—	—	—	15	36.1	34.9	24.9	29.1	38.7	30.1	24.9	
16	Complete mineral manure and nitrate of soda (= 43 lbs. N)	—	275	3.5	500	100	100	—	—	—	16	48.1 ³	47.6	41.5	37.4	40.4	39.9	41.5	
17	Nitrate of soda (= 43 lbs. N)	—	275	—	—	—	—	—	—	—	17	34.3	33.5	30.1	27.0	28.9	25.7	23.8	
18	Mineral manure without superphosphate, and ammonium salts (= 86 lbs. N) since 1905 (after minerals and nitrogen equal to constituents of 1 ton of hay, 1865-1904)	440	—	—	500	100	100	—	—	—	18	—	33.1 ⁴	32.2	31.1	29.1 ¹	29.3 ⁴	23.7	
19	Dung every fourth year since 1905 (after superphosphate, sulphate of potash, and nitrate of soda, 1872-1904)	—	—	—	—	—	—	—	14	—	19	—	38.6 ⁵	37.2	43.6	39.2 ⁷	26.4 ⁸	25.4	
20	Dung every fourth year since 1905; sulphate of potash, superphosphate, and nitrate of soda (= 26 lbs. N) in other years (after superphosphate and nitrate of potash, 1872-1904)	—	168	1.8	100	—	—	—	14	—	20	—	36.5 ⁵	35.7	40.3	41.2 ⁷	33.1 ⁸	33.5	

¹ 7 years only, 1859-65.² 4 " " 1862-65.³ 8 " " 1858-65.⁴ 11 " " 1865-75.⁵ 4 years only 1872-75.⁶ 8 " " 1898-1905.⁷ 9 " " 1896-1904.⁸ 11 " " 1905-15.

TABLE II.
NUMBER OF SPECIES AND PERCENTAGE OF EACH SPECIES AND GROUP OF SPECIES.

Description of Manure.	NO MANURE.														
	1856 and Since.							After F.Y.M. 8 Years, 1856-1863.				After Amm. Salts, 42 Years, 1856-1897.			
	3			12				2				5 ¹			
Plot numbers															
Seasons	1903	1914	1914	1919	1919	1914	1919	1914	1914	1919	1919	1903	1914	1919	
Unlined (U), or lined (L)	U	U	L	U	L	U	U	U	L	U	L	U	U	U	
GRAMINACEÆ.															
Number of species	13	13	12	12	12	14	12	13	13	13	14	13	11	10	
1. <i>Agrostis vulgaris</i>	0.19	12.52	2.86	8.34	1.53	8.34	4.75	7.94	1.86	8.42	0.50	11.65	17.03	4.46	
2. <i>Aira caspitosa</i>	—	—	—	—	—	—	—	—	—	—	—	0.01	—	0.26	
3. <i>Alopecurus pratensis</i>	0.59	0.28	1.02	0.29	0.61	1.38	1.63	1.61	1.86	1.52	1.46	0.27	0.11	0.73	
4. <i>Anthraxanthum odoratum</i>	1.34	2.69	1.02	6.97	3.06	2.88	7.60	3.87	1.44	8.65	1.68	12.29	8.18	11.62	
5. <i>Arrhenatherum avenaceum</i> . . .	0.10	0.11	0.20	0.29	0.51	1.07	4.34	0.10	—	1.40	0.28	0.19	0.39	1.66	
6. <i>Avena flavescens</i>	0.92	0.56	1.02	0.88	2.76	0.63	0.54	0.97	1.62	1.17	3.70	0.01	—	—	
7. " <i>pubescens</i>	4.76	3.82	13.88	4.12	19.10	2.26	3.53	4.71	17.64	4.68	20.16	0.01	0.50	0.21	
8. <i>Brisa media</i>	20.15	4.10	10.26	1.97	8.89	10.09	2.17	5.42	2.63	3.39	1.68	—	—	—	
9. <i>Bromus mollis</i>	—	—	—	—	—	—	—	—	—	—	—	0.01	0.22	—	
10. <i>Cynosurus cristatus</i>	0.27	0.11	—	0.20	—	0.03	—	0.32	0.12	0.58	0.11	0.03	—	—	
11. <i>Dactylis glomerata</i>	1.00	3.65	3.06	8.34	7.35	4.39	14.25	3.68	4.73	10.53	15.01	3.2	9.18	8.82	
12. <i>Festuca ovina</i>	17.82	23.62	22.98	6.68	5.01	32.90	10.04	24.85	13.50	5.26	4.59	55.95	45.57	49.47	
13. <i>Holcus lanatus</i>	5.07	2.75	4.29	9.13	7.66	2.70	4.88	4.20	4.85	10.53	9.18	0.03	0.22	0.57	
14. <i>Lolium perenne</i>	—	0.06	—	—	—	0.06	0.07	0.32	0.06	0.53	0.17	—	—	—	
15. <i>Poa pratensis</i>	0.33	0.06	1.53	0.15	1.94	0.31	0.41	0.45	1.38	0.53	1.79	0.90	1.11	1.35	
17. " <i>trivialis</i>	0.01	—	0.05	—	0.10	0.06	—	—	0.06	—	0.28	—	0.17	—	
Stalks [not determined]	—	—	0.66	—	—	0.88	—	0.06	0.06	—	—	—	0.60	—	
Total	52.23	54.33	62.83	47.36	58.52	67.98	54.21	58.59	61.81	57.19	60.59	82.37	83.28	76.15	
LEGUMINOSÆ.															
Number of species	4	4	3	3	3	4	3	4	4	3	4	0	3	1	
1. <i>Lathyrus pratensis</i>	2.55	0.45	2.66	0.88	1.23	0.94	1.97	0.71	2.33	0.82	2.13	—	0.17	—	
2. <i>Lotus corniculatus</i>	3.64	3.31	3.47	1.57	2.45	4.13	1.70	3.68	2.04	2.60	2.46	—	0.17	0.36	
4. <i>Trifolium pratense</i>	1.44	1.96	2.25	2.06	1.74	2.07	1.56	0.97	2.75	0.82	0.90	—	0.11	—	
5. " <i>repens</i>	0.14	0.06	—	—	—	0.03	—	0.13	0.12	—	0.06	—	—	—	
Total	7.77	5.78	8.38	4.51	5.42	7.17	5.23	5.49	7.23	4.33	5.55	—	0.45	0.36	
MISCELLANEOUS SPECIES.															
Number of species	26	23	18	14	16	23	16	18	19	16	15	8	17	14	
1 and 2. <i>Ranunculus acris et bulbosus</i>	1.89	0.17	0.97	0.39	2.55	0.09	0.47	0.26	1.32	0.53	4.37	—	0.11	0.31	
3. <i>Viola canina</i>	—	—	—	—	—	—	—	—	—	—	—	—	0.06	—	
4. <i>Cerastium vulgatum</i>	1.13	0.22	0.61	0.59	0.82	0.38	0.81	0.45	0.60	0.76	1.01	0.20	0.17	0.42	
5. <i>Stellaria graminea</i>	0.85	0.06	0.10	—	0.10	0.09	0.27	0.06	0.04	—	0.06	—	0.11	0.10	
6. <i>Linum catharticum</i>	—	—	—	—	—	—	—	0.06	0.06	—	0.45	—	—	—	
7. <i>Agrimonia eupatoria</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
8. <i>Alchemilla vulgaris</i>	—	—	—	—	—	0.03	—	—	—	—	—	—	—	—	
10. <i>Potentilla reptans</i>	0.32	0.06	0.10	—	—	—	—	—	—	—	—	—	—	—	
11. <i>Poterium sanguisorba</i>	13.81	1.74	2.55	5.70	3.06	—	—	—	—	—	—	—	—	—	
14. <i>Conopodium denudatum</i>	0.92	0.45	0.10	4.6	0.61	0.44	10.45	0.52	0.12	4.33	0.67	0.07	0.11	1.30	
15. <i>Heracleum sphondylium</i>	—	—	—	—	—	—	—	—	—	—	—	—	0.28	—	
16. <i>Pimpinella saxifraga</i>	0.44	0.56	0.72	—	0.10	0.38	0.14	0.58	0.72	0.06	0.17	—	0.17	0.05	
17. <i>Galium verum</i>	0.01	0.06	—	—	—	0.09	—	0.19	—	0.41	—	1.40	0.95	1.97	
18. <i>Scabiosa arvensis</i>	0.80	0.11	0.87	—	1.63	0.45	0.95	0.19	0.12	0.12	0.45	0.30	1.11	0.62	
19. <i>Achillea millefolium</i>	2.67	0.73	0.97	1.57	1.84	1.38	1.97	0.84	0.72	1.17	1.18	0.04	0.39	0.73	
20. <i>Centaurea nigra</i>	4.05	8.70	10.46	5.70	6.13	5.39	2.99	7.10	7.48	4.80	4.48	0.70	6.96	3.94	
22. <i>Hieracium pilosella</i>	0.17	0.06	0.10	—	—	0.03	—	—	0.06	—	—	—	0.17	—	
23. <i>Hypochaeris radicata</i>	0.01	—	—	—	—	0.06	—	—	—	—	—	—	0.17	—	
24. <i>Leontodon hispidus</i>	5.98	17.06	3.52	6.87	1.53	6.39	2.58	16.01	8.31	2.75	1.68	—	—	0.10	
26. <i>Taraxacum officinale</i>	0.01	0.06	—	—	—	—	—	0.06	—	—	—	—	—	—	
27. <i>Tragopogon pratensis</i>	0.04	0.06	—	—	—	0.03	0.20	—	0.04	0.12	—	—	—	—	
28. <i>Primula veris</i>	0.11	—	—	—	—	0.03	—	—	—	—	—	—	—	—	
29. <i>Plantago lanceolata</i>	1.98	3.25	3.52	18.93	11.95	5.08	14.92	5.29	7.66	20.34	15.23	—	0.22	0.42	
30. <i>Veronica chamadrys</i>	0.63	0.06	0.10	0.05	0.10	0.06	—	0.13	0.12	0.06	0.34	—	0.11	0.05	
31. <i>Ajuga reptans</i>	0.13	0.06	—	0.10	—	0.03	0.14	—	—	0.12	—	—	—	—	
32. <i>Prunella vulgaris</i>	0.05	0.06	—	—	—	0.03	—	—	—	—	—	—	—	—	
33. <i>Thymus serpyllum</i>	0.01	—	—	—	—	—	—	—	—	—	—	—	—	—	
34. <i>Rumex acetosa</i>	2.21	0.34	0.56	1.96	4.19	0.22	2.99	0.45	0.42	1.52	2.80	14.84	1.34	12.24	
35. <i>Lucula campestris</i>	0.49	0.39	0.36	0.15	0.20	0.44	0.27	0.52	0.42	0.12	0.11	0.07	0.22	0.78	
36. <i>Carex praecox</i>	1.24	1.24	0.77	0.54	0.36	1.82	0.27	0.06	0.06	—	—	—	—	—	
Mosses	0.05	—	0.10	—	—	—	—	—	0.04	—	—	0.01	—	—	
Traces of various species	—	0.06	0.15	0.39	0.21	—	0.27	0.06	0.06	0.12	0.17	—	0.06	0.16	
Total	40.00	35.56	26.63	47.54	35.38	22.94	39.69	32.83	28.43	37.33	33.17	17.63	12.71	23.09	
Undetermined	—	4.33	2.16	0.59	0.68	1.91	0.87	3.09	2.53	1.15	0.69	—	3.56	0.40	

Missing numbers of species not found in samples from these plots.

TABLE III.
NUMBER OF SPECIES, AND PERCENTAGE OF EACH SPECIES AND GROUP OF SPECIES.

Description of Manure.	MIXED MINERAL MANURE = Potassium, Sodium and Magnesium Sulphates, and Superphosphate of Lime.																	
	Alone, 1896 and since.					Without Potash, after 6 Years; with Potash, 1896-61.					After Ammonium Salts, 13 Years, 1896-68.			After Nitrate of Soda, 18 Years, 1895-75.				
	7					8					6			15				
Plot numbers	1903	1914	1914	1919	1919	1903	1914	1914	1919	1919	1903	1914	1919	1903	1914	1919	1903	1914
Seasons	1903	1914	1914	1919	1919	1903	1914	1914	1919	1919	1903	1914	1919	1903	1914	1919	1903	1914
Unlimed (U) or Limed (L)	U	U	L	U	L	U	U	L	U	L	U	U	U	U	U	U	U	U
GRAMINACEÆ.																		
Number of species	16	14	12	12	12	15	15	14	13	13	15	12	12	16	13	12	16	13
1. <i>Agrostis vulgaris</i>	3.34	7.00	4.25	5.38	2.01	0.72	7.77	5.19	3.83	1.95	2.51	7.25	7.54	2.99	11.96	11.31	2.99	11.96
2. <i>Aira caspitosa</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0.01	—	—	0.01	—
3. <i>Alopecurus pratensis</i>	4.51	1.69	9.74	1.73	15.20	0.55	0.41	0.96	1.17	1.44	0.59	1.89	2.97	10.24	13.69	29.85	10.24	13.69
4. <i>Anthoxanthum odoratum</i>	1.36	4.21	0.56	3.55	0.45	1.50	3.85	3.14	4.58	1.52	1.90	4.96	4.25	1.67	3.04	3.49	1.67	3.04
5. <i>Arrhenatherum avenaceum</i>	1.16	1.21	1.97	3.05	2.62	4.20	3.02	3.91	7.92	17.94	1.94	1.15	3.18	0.16	0.52	1.45	0.16	0.52
6. <i>Avena flavescens</i>	6.64	1.84	3.94	0.71	0.96	3.94	2.06	3.08	1.17	1.61	1.47	0.81	0.21	5.53	1.68	0.85	5.53	1.68
7. " <i>pubescens</i>	4.28	2.58	4.45	2.84	8.81	8.04	5.16	9.17	3.33	11.93	7.51	6.47	5.09	4.18	1.99	1.96	4.18	1.99
8. <i>Brisa media</i>	0.13	—	—	—	—	5.87	1.51	9.17	0.42	1.95	0.18	—	—	0.22	—	—	0.22	—
9. <i>Bromus mollis</i>	0.59	2.11	15.48	0.05	0.60	0.46	0.07	0.13	—	—	0.21	0.67	0.05	3.42	2.89	0.09	3.42	2.89
10. <i>Cynosurus cristatus</i>	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11. <i>Dactylis glomerata</i>	4.97	10.17	12.39	21.52	18.57	1.12	3.99	2.82	3.75	5.08	3.51	7.33	21.03	0.48	2.41	4.93	0.48	2.41
12. <i>Festuca ovina</i>	7.67	31.44	13.19	7.11	5.39	9.48	24.74	20.77	0.83	5.92	8.80	27.37	6.69	15.04	13.64	7.31	15.04	13.64
13. " <i>pratensis</i>	0.53	0.21	—	—	—	0.11	—	—	—	—	0.08	—	—	0.03	—	—	0.03	—
14. <i>Holcus lanatus</i>	3.07	3.42	2.53	4.26	1.56	6.31	7.90	6.67	11.00	5.16	2.87	3.37	4.35	2.35	5.56	5.95	2.35	5.56
15. <i>Lolium perenne</i>	0.11	0.16	—	—	—	0.12	0.41	0.06	0.29	0.13	0.12	—	—	0.02	0.16	—	0.02	0.16
16. <i>Poa pratensis</i>	2.34	1.42	1.32	1.17	1.61	0.98	1.10	1.35	1.08	1.95	3.74	1.15	1.27	2.52	0.42	1.36	2.52	0.42
17. " <i>trivialis</i>	1.00	0.53	1.85	0.36	1.21	0.10	0.21	0.77	0.58	0.68	0.19	0.15	0.05	1.20	0.42	0.21	1.20	0.42
Stalks, not determined	—	0.11	0.56	—	—	—	0.34	0.45	—	—	—	—	—	—	0.37	—	—	0.37
Total	41.75	68.10	72.23	51.73	58.98	43.50	62.75	67.64	45.95	57.26	35.62	62.56	56.68	50.06	58.75	68.76	50.06	58.75
LEGUMINOSÆ.																		
Number of species	4	5	4	5	3	4	4	4	4	3	4	5	4	5?	4	2	4	2
1. <i>Lathyrus pratensis</i>	22.04	10.64	15.80	7.11	19.53	3.70	3.37	2.31	4.17	4.91	30.94	17.35	9.77	16.29	27.65	5.27	16.29	27.65
2. <i>Lolus corniculatus</i>	0.43	0.63	0.12	0.46	0.03	12.24	1.79	1.99	1.25	1.61	2.30	1.59	1.11	0.01	0.10	—	0.01	0.10
4. <i>Trifolium pratense</i>	6.41	4.09	2.73	1.02	0.03	1.38	5.36	4.87	4.91	1.52	5.91	5.11	0.42	5.76	2.57	—	5.76	2.57
5. " <i>repens</i>	4.27	0.84	1.00	0.05	—	1.25	0.14	0.13	0.04	—	1.68	0.15	0.05	6.75	2.41	—	6.75	2.41
6. " <i>minus</i> ?	—	—	—	—	—	—	—	—	—	—	—	—	—	0.17	—	—	—	—
7. <i>Vicia sepium</i> ?	—	0.11	—	0.10	—	—	—	—	—	—	—	0.04	—	—	—	—	—	—
Total	33.15	16.91	19.65	8.74	19.59	18.57	10.66	9.30	10.37	8.04	40.83	24.24	11.35	28.98	32.73	5.36	28.98	32.73
MISCELLANEOUS SPECIES.																		
Number of species	17	14	14	15	15	23	16	14	15	16	21	16	13	15	12	11	15	12
1 and 2. <i>Ranunculus acris et bulbosus</i>	2.85	0.90	0.68	1.93	3.98	10.90	0.55	0.64	2.08	4.57	3.72	1.04	4.03	6.20	0.79	2.64	6.20	0.79
3. <i>Viola canina</i>	—	—	—	—	—	—	—	—	—	—	0.12	0.04	—	—	—	—	—	—
4. <i>Cerastium vulgatum</i>	0.27	0.21	0.04	0.05	0.10	1.09	0.69	0.64	0.50	1.10	0.13	0.07	—	0.04	0.05	—	0.04	0.05
5. <i>Stellaria graminea</i>	0.10	—	—	0.15	—	0.39	0.21	0.06	0.08	0.13	0.01	—	0.05	—	—	—	—	—
7. <i>Agrimonia eupatoria</i>	—	—	—	—	—	—	—	—	—	—	0.04	—	—	—	—	—	—	—
10. <i>Potentilla reptans</i>	—	—	—	—	—	0.01	—	—	—	—	—	0.01	—	—	—	—	—	—
12. <i>Spirea ulmaria</i>	—	—	—	—	—	0.06	—	—	—	—	—	—	—	—	—	—	—	—
13. <i>Anthriscus sylvestris</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.05	—	—	—
14. <i>Conopodium denudatum</i>	1.69	0.79	0.28	0.44	3.07	0.79	0.14	—	2.83	0.51	1.28	—	6.69	1.07	0.21	3.57	1.07	0.21
15. <i>Heracleum sphondylium</i>	1.87	0.53	0.32	4.16	1.56	—	—	—	—	—	0.27	0.07	0.32	—	—	0.30	—	—
16. <i>Pimpinella saxifraga</i>	0.53	—	—	—	0.03	1.04	0.14	0.26	0.17	0.13	1.26	0.30	0.11	0.20	—	—	—	—
17. <i>Galium verum</i>	—	0.16	—	0.20	—	0.32	0.34	0.26	0.13	—	0.26	—	—	—	—	—	—	—
18. <i>Scabiosa arvensis</i>	0.15	0.53	0.80	0.10	0.05	0.24	0.82	1.47	0.83	4.40	0.81	0.81	1.38	0.01	—	—	0.01	—
19. <i>Achillea millefolium</i>	8.05	2.53	0.68	6.30	0.96	3.50	2.75	1.21	4.75	2.03	7.62	1.11	4.99	0.96	4.25	5.27	0.96	4.25
20. <i>Centaurea nigra</i>	1.03	6.84	3.49	2.54	1.11	7.21	9.21	9.23	4.75	4.48	1.35	0.07	1.80	0.81	0.94	0.60	0.81	0.94
21. <i>Chrysanthemum leucanthemum</i>	—	—	—	—	—	—	—	—	—	—	0.09	—	—	—	—	—	—	—
22. <i>Hieracium pilosella</i>	—	—	—	—	—	0.08	—	—	—	—	—	—	—	—	—	—	—	—
24. <i>Leontodon hispidus</i>	—	—	—	—	—	0.85	1.03	0.26	0.67	0.25	—	—	—	—	—	—	—	—
26. <i>Taraxacum vulgare</i>	—	—	0.04	—	0.05	0.05	—	—	—	—	0.13	0.04	—	0.08	0.16	1.28	0.08	0.16
27. <i>Tragopogon pratensis</i>	1.11	0.21	0.48	0.05	1.46	0.33	—	0.19	—	0.08	0.29	0.11	0.11	—	0.05	—	—	—
29. <i>Plantago lanceolata</i>	0.05	0.74	0.20	1.32	0.50	5.85	8.66	5.19	18.25	7.61	0.09	0.11	0.11	0.20	0.26	3.74	0.20	0.26
30. <i>Veronica chamaedrys</i>	1.52	—	0.04	—	0.10	0.20	0.14	—	0.12	0.13	0.52	0.04	—	0.17	—	—	—	—
32. <i>Prunella vulgaris</i>	—	—	—	—	—	0.07	—	—	—	—	—	—	—	—	—	—	—	—
34. <i>Rumex acetosa</i>	3.71	0.21	0.44	10.55	7.10	1.91	0.55	0.51	6.83	7.70	5.24	0.26	10.82	1.56	0.21	7.31	1.56	0.21
35. <i>Luzula campestris</i>	0.21	0.21	0.04	0.30	0.05	0.36	0.41	0.26	0.29	0.17	0.32	0.19	0.64	0.57	0.31	0.21	0.57	0.31
36. <i>Carex præcox</i>	0.41	—	—	—	—	0.16	0.07	—	—	—	0.03	—	—	0.06	—	—	—	—
37. <i>Ophioglossum vulgatum</i>	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	—	—	—	—
Traces of various species	—	0.05	0.04	—	0.05	—	0.07	0.26	0.08	0.13	—	0.07	0.21	—	0.05	0.21	—	0.05
Mosses	—	—	—	—	—	0.01	—	—	—	—	—	—	—	—	—	—	—	—
Total	25.10	14.65	7.57	38.97	21.27	37.93	25.78	20.44	42.36	33.46	23.55	12.37	31.26	20.96	7.33	25.39	20.96	7.33
Undetermined	—	0.34	0.55	0.56	0.16	—	0.81	2.62	1.32	1.24	—	0.83	0.71	—	1.19	0.49	—	1.19

Missing numbers of species not present in samples from these plots.

TABLE IV.
NUMBER OF SPECIES AND PERCENTAGE OF EACH SPECIES AND GROUP OF SPECIES.

Description of Manure.	MIXED MINERAL MANURE.		SUPERPHOSPHATE.						NITRATE OF SODA.								
	After Ammonium Salts, 42 Years, 1856-1897.		Alone, 1856 and since.						Alone = 43 lbs. N.			= 43 lbs. N.				= 86 lbs. N.	
												With Mixed Mineral Manure.					
Plot numbers	5 ^a		4 ⁱ						17			16				14	
Seasons	1914	1919	1903	1914	1914	1919	1919	1903	1914	1919	1914	1914	1919	1919	1903	1914	1919
Unlimed (U) or Limed (L)	U	U	U	U	L	U	L	U	U	U	U	L	U	L	U	U	U
GRAMINACEÆ.																	
Number of species	11	11	15	14	12	14	13	15	14	14	12	12	11	12	13	12	11
1. <i>Agrostis vulgaris</i>	16.54	8.39	0.03	0.93	1.56	0.74	0.45	1.76	12.33	6.03	4.77	0.14	1.25	0.24	0.14	1.43	0.55
3. <i>Alopecurus pratensis</i>	3.96	11.11	0.31	0.06	1.25	0.99	1.48	9.74	14.29	12.80	25.99	25.47	50.47	35.93	28.71	22.30	53.55
4. <i>Anthraxanthum odoratum</i>	0.10	5.10	2.40	3.98	1.50	3.16	1.82	11.06	4.81	7.32	2.84	0.14	2.00	0.03	0.13	0.10	0.37
5. <i>Arrhenatherum avenaceum</i>	0.38	2.27	0.03	0.44	0.06	0.87	0.06	—	0.28	0.32	2.72	1.33	3.25	3.12	17.28	40.47	23.34
6. <i>Avena flavescens</i>	—	—	2.83	2.18	1.81	3.10	4.31	1.78	1.19	1.29	3.58	2.99	1.17	1.08	0.31	1.86	0.73
7. " <i>pubescens</i>	1.21	1.7	9.77	9.94	12.67	13.90	19.75	8.68	3.83	4.84	5.00	13.84	2.75	17.64	2.32	3.57	3.60
8. <i>Brisa media</i>	—	—	11.23	2.24	3.37	1.30	2.84	2.20	1.05	0.54	—	—	—	—	—	—	—
9. <i>Bromus mollis</i>	2.97	0.06	—	—	—	—	—	0.20	0.14	—	7.83	2.99	—	0.03	22.97	5.15	0.51
10. <i>Cynosurus cristatus</i>	—	—	0.03	0.06	—	0.39	0.17	0.18	—	0.11	—	—	—	—	—	—	—
11. <i>Dactylis glomerata</i>	3.74	7.37	1.30	4.60	1.75	11.39	6.36	0.92	5.72	8.29	9.54	9.43	20.06	18.78	0.71	6.10	2.22
12. <i>Festuca ovina</i>	33.85	19.50	8.82	21.20	22.16	5.15	5.45	12.83	14.21	4.31	7.61	30.57	1.83	11.34	2.75	5.87	5.05
13. " <i>pratensis</i>	—	—	0.02	—	—	—	—	0.10	—	—	—	—	—	—	—	—	—
14. <i>Holcus lanatus</i>	0.77	1.13	4.74	8.64	6.37	9.93	6.81	4.84	7.39	10.87	1.42	0.55	1.67	0.21	0.02	—	—
15. <i>Lolium perenne</i>	—	—	0.02	0.12	—	0.22	—	0.54	1.39	0.75	—	—	—	—	0.04	0.08	—
16. <i>Poa pratensis</i>	4.62	6.24	0.83	0.93	0.81	0.37	0.20	0.20	0.14	0.27	0.68	0.28	1.17	0.54	9.20	2.18	0.80
17. " <i>trivialis</i>	0.05	0.11	0.04	0.56	0.44	1.43	1.36	0.96	0.07	0.54	0.11	1.56	0.25	0.42	0.95	1.27	1.02
Stalks, not determined	1.15	—	—	—	0.12	—	—	—	1.19	—	2.27	0.60	—	—	—	0.71	—
Total	75.34	62.98	43.00	55.88	53.87	52.14	52.90	55.99	68.03	58.28	74.36	89.89	85.87	89.36	85.53	91.21	92.8
LEGUMINOSÆ.																	
Number of species	4	3	4	5	4	5	3	4	3	2	3	3	1	2	2	1	1
1. <i>Lathyrus pratensis</i>	1.98	1.25	4.77	1.68	11.24	1.61	5.00	0.12	0.07	0.05	14.41	1.33	1.17	0.72	3.34	4.00	2.38
2. <i>Lotus corniculatus</i>	3.79	3.06	7.28	1.06	2.12	0.75	3.63	2.28	0.35	0.32	—	—	—	0.03	—	—	—
3. <i>Ononis arvensis</i>	—	—	—	0.44	—	0.16	—	—	—	—	—	—	—	—	—	—	—
4. <i>Trifolium pratense</i>	2.47	—	2.71	2.98	4.87	0.12	0.85	0.01	0.14	—	0.79	0.28	—	—	—	—	—
5. " <i>repens</i>	0.11	—	2.82	1.31	0.19	0.06	—	0.18	—	—	0.40	0.64	—	—	0.01	—	—
6. <i>Vicia sepium</i> ?	—	0.23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	8.35	4.54	17.58	7.47	18.42	2.70	9.48	2.59	0.56	0.37	15.60	2.25	1.17	0.75	3.35	4.00	2.38
MISCELLANEOUS SPECIES.																	
Number of species	17	17	22	15	17	13	16	20	14	15	11	10	9	11	9	6	4
1 and 2. <i>Ranunculus acris et bulbosus</i>	0.14	0.62	1.53	0.37	1.12	1.55	4.54	3.92	0.63	0.81	0.28	0.60	0.33	0.81	0.19	0.12	—
4. <i>Cerastium vulgatum</i>	0.49	0.17	0.71	0.55	0.94	0.56	1.14	—	0.28	0.32	—	—	—	—	0.01	—	—
5. <i>Stellaria graminea</i>	0.33	0.34	0.03	0.06	0.12	0.03	0.11	0.22	—	0.05	—	—	—	—	—	—	—
10. <i>Potentilla reptans</i>	—	—	0.02	—	—	—	—	0.09	—	—	—	—	—	—	—	—	—
11. <i>Potierium sanguisorba</i>	—	—	8.48	1.06	0.06	0.77	0.11	0.03	—	—	—	—	—	—	—	—	—
13. <i>Anthriscus sylvestris</i>	—	—	—	—	—	—	—	—	—	—	0.11	0.87	0.92	3.42	9.50	1.03	2.41
14. <i>Conopodium denudatum</i>	—	0.11	0.23	—	—	0.37	0.23	0.61	0.63	1.18	0.06	—	0.50	1.20	0.02	—	—
15. <i>Heracleum sphondylium</i>	0.11	0.28	—	0.37	—	—	—	0.01	—	0.27	—	—	—	0.30	—	—	—
16. <i>Pimpinella saxifraga</i>	0.19	0.40	0.53	—	0.50	—	0.23	0.03	—	—	—	—	—	—	—	—	—
17. <i>Galium verum</i>	0.27	0.23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
18. <i>Scabiosa arvensis</i>	0.08	0.23	0.33	0.25	0.81	—	1.48	—	—	—	—	—	—	—	—	—	—
19. <i>Achillea millefolium</i>	0.82	2.83	1.80	1.55	1.12	2.23	2.27	2.82	1.19	0.91	2.84	3.08	0.21	0.96	0.12	0.12	0.04
20. <i>Centaurea nigra</i>	—	8.85	3.40	4.77	8.64	7.99	7.51	5.79	11.20	8.02	8.61	0.57	0.83	0.68	0.42	0.03	—
22. <i>Hieracium pilosella</i>	—	0.08	0.44	—	0.06	—	—	2.59	—	—	—	—	—	—	—	—	—
23. <i>Hypochaeris radicata</i>	0.19	0.11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24. <i>Leontodon hispidus</i>	0.05	—	14.66	12.43	6.81	2.48	2.27	3.68	4.39	3.34	—	—	—	—	—	—	—
25. <i>Senecio jacobaea</i>	—	—	—	—	—	—	—	—	0.14	—	—	—	—	—	—	—	—
26. <i>Taraxacum vulgare</i>	—	—	0.08	—	—	—	—	1.49	0.14	0.16	1.36	0.32	7.24	0.06	0.67	1.94	1.17
27. <i>Tragopogon pratensis</i>	—	0.45	0.12	—	0.06	—	0.06	0.10	—	—	0.06	0.18	—	0.12	—	—	—
29. <i>Plantago lanceolata</i>	0.14	0.57	2.49	6.77	4.00	17.80	11.24	10.69	13.87	24.01	2.84	0.41	2.50	1.50	—	—	—
30. <i>Veronica chamaedrys</i>	0.16	0.06	0.44	0.12	0.12	0.19	0.17	0.22	0.14	—	—	—	—	—	—	—	—
31. <i>Aruga reptans</i>	—	—	0.01	—	—	—	—	0.46	—	—	0.16	—	—	—	—	—	—
32. <i>Prunella vulgaris</i>	—	—	0.08	—	—	—	—	—	—	—	—	—	—	—	—	—	—
34. <i>Rumex acetosa</i>	2.47	18.03	1.51	0.68	0.62	10.17	6.24	1.80	0.35	0.86	0.11	0.37	1.00	0.72	0.57	0.52	1.02
35. <i>Luizula campestris</i>	0.71	4.31	0.57	0.50	0.56	0.25	0.28	0.84	0.28	0.05	0.06	0.02	—	—	—	—	—
36. <i>Carex praeox</i>	—	—	0.53	0.06	0.12	—	—	0.60	0.14	0.10	—	—	—	—	—	—	—
Mosses	—	—	0.01	—	—	—	—	0.02	—	—	—	—	—	—	0.01	—	—
Traces of various species	—	0.11	—	0.12	0.19	0.12	0.17	—	0.07	0.16	0.06	0.07	0.04	—	—	0.08	0.04
Total	15.10	32.25	39.42	33.53	25.20	44.03	36.33	41.42	30.27	41.05	8.35	6.75	12.82	9.51	11.12	3.81	4.68
Undetermined	1.21	0.23	—	3.12	2.51	1.13	1.29	—	1.14	0.30	1.69	1.11	0.14	0.38	—	0.98	0.14

Missing numbers of species not found in samples from these plots.

TABLE V.
NUMBER OF SPECIES, AND PERCENTAGE OF EACH SPECIES AND GROUP OF SPECIES.

AMMONIUM SALTS (400 lbs. per acre = 86 lbs. N).										AMMONIUM SALTS (600 lbs. per acre = 129 lbs. N).									
Plot numbers	With Mixed Mineral Manure.								With Mixed Mineral Manure.										
	With Potash.				Without Potash.				As Plot 9.				With Silicate of Soda since 1906.						
Seasons	9				10				11 ¹				11 ²						
Unlimed (U) or Limed (L).	U	U	L	U	L	U	L	U	L	U	U	L	U	L	U	L	U	L	
GRAMINACEÆ.																			
Number of species	12	9	10	8	9	8	8	9	8	8	7	8	7	8	8	7	9	7	
1. <i>Agrostis vulgaris</i>	3·81	18·16	12·69	12·42	2·26	2·95	3·11	4·01	0·54	1·42	0·51	2·12	1·65	0·94	0·53	0·23	0·72	0·03	
2. <i>Aira caespitosa</i>	—	—	—	—	—	—	—	0·03	—	—	—	—	—	—	—	—	—	—	
3. <i>Alopecurus pratensis</i>	4·08	1·65	17·65	0·67	25·94	18·59	46·45	20·77	76·83	28·52	1·15	27·21	0·77	63·91	17·54	49·26	29·78	76·62	
4. <i>Anthoxanthum odoratum</i>	16·18	38·53	12·65	5·42	1·12	49·37	15·18	21·02	1·08	0·98	0·08	2·05	0·02	0·14	0·04	—	0·11	—	
5. <i>Arrhenatherum avenaceum</i>	43·30	8·49	38·57	46·75	47·20	4·76	9·19	25·92	8·13	23·01	6·57	27·04	31·34	15·51	20·72	25·39	45·66	16·34	
6. <i>Avena flavescens</i>	0·16	0·05	0·17	—	0·02	—	—	—	—	—	—	—	—	—	—	—	—	—	
7. " <i>pubescens</i>	0·06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·03	—	
9. <i>Bromus mollis</i>	0·01	—	0·33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
11. <i>Dactylis glomerata</i>	5·14	5·04	6·86	3·29	6·82	1·00	0·73	1·57	1·79	0·15	0·20	4·94	0·19	5·66	0·34	10·86	2·77	7·31	
12. <i>Festuca ovina</i>	7·52	15·28	9·22	3·58	5·90	19·02	14·77	6·87	5·20	0·02	0·12	0·21	0·08	0·01	0·04	0·03	0·06	0·03	
14. <i>Holcus lanatus</i>	3·94	4·01	2·15	12·39	0·76	1·05	1·51	11·56	0·06	45·58	99·90	31·95	64·80	11·63	59·43	6·09	20·36	0·03	
16. <i>Poa pratensis</i>	11·67	1·80	7·53	0·21	5·54	0·86	4·30	0·31	5·97	0·17	—	2·71	—	1·95	0·68	3·51	0·11	0·24	
17. " <i>trivialis</i>	0·01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Stalks, not determined	—	0·72	0·13	0·07	0·05	0·33	3·15	0·22	—	—	0·47	1·15	—	0·02	0·49	2·75	—	—	
Traces of various species	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·04	—	—	—	
Total	95·88	93·73	97·95	84·80	95·61	97·93	98·39	92·28	99·60	99·85	100·00	99·38	98·85	99·77	99·85	98·12	99·60	100·00	
LEGUMINOSÆ.																			
Number of species	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
1. <i>Lathyrus pratensis</i>	0·01	—	—	—	0·10	—	—	—	—	—	—	—	—	—	—	—	—	—	
Total	0·01	—	—	—	0·10	—	—	—	—	—	—	—	—	—	—	—	—	—	
MISCELLANEOUS SPECIES.																			
Number of species	7	5	3	3	4	4	2	1	1	2	0	2	1	2	0	2	1	0	
4. <i>Cerastium vulgatum</i>	0·07	—	—	—	—	—	—	—	—	0·02	—	—	—	—	—	—	—	—	
5. <i>Stellaria graminea</i>	0·01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
10. <i>Potentilla reptans</i>	—	0·05	—	0·09	—	0·10	—	—	—	—	—	—	—	—	—	—	—	—	
14. <i>Conopodium denudatum</i>	0·26	0·11	—	0·05	0·11	0·02	—	—	—	—	—	—	—	—	—	—	—	—	
15. <i>Heracleum sphondylium</i>	0·60	0·62	0·04	—	0·27	—	—	—	—	—	—	0·28	—	0·05	—	0·56	—	—	
17. <i>Galium verum</i>	—	—	—	—	—	0·05	0·09	—	—	—	—	—	—	—	—	—	—	—	
19. <i>Achillea millefolium</i>	0·37	0·11	0·25	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
20. <i>Centauria nigra</i>	—	—	—	—	0·14	—	—	—	—	—	—	—	—	—	—	—	—	—	
32. <i>Prunella vulgaris</i>	0·01	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
34. <i>Rumex acetosa</i>	2·79	4·37	0·66	14·82	3·51	1·14	0·23	7·40	0·38	0·13	—	0·07	1·15	0·11	—	0·36	0·39	—	
Traces of various species	—	0·05	0·04	0·04	0·02	0·02	0·05	0·05	0·02	—	—	—	—	0·02	—	0·63	0·01	—	
Total	4·11	5·31	0·99	15·00	4·05	1·33	0·37	7·45	0·40	0·15	—	0·35	1·15	0·18	—	0·95	0·40	—	
Undetermined	—	0·96	1·06	0·20	0·24	0·74	1·24	0·27	—	—	—	0·27	—	0·05	0·15	0·93	—	—	

Missing numbers of species not found in samples from these plots.

TABLE VI.
NUMBER OF SPECIES AND PERCENTAGE OF EACH SPECIES AND GROUP OF SPECIES.

	AMMONIUM SALTS.										FARMYARD MANURE.									
	Alone, = 43 lbs. N: also F.Y.M. 8 Years, 1856-63.				= 86 lbs. N: with Superphosphate.					= 86 lbs. N: with Mixed Minerals without Superphosphate: after 33 Years, 1865-1904.		Every Fourth Year with Fish Guano alternately; after cut Wheat Straw, Minerals and Ammonium Salts.				Every Fourth Year, after Superphosphate, Potash, and Nitrate of Soda, 33 Years, 1872-1903.		Every Fourth Year, with Sulph. Potash, Superphosphate, and Nitrate of Soda in other Years: after Superphosphate and Nitrate, 33 Years, 1872-1904.		
Plot numbers	I				4 ^b					18		13				19		20		
Seasons	1914	1914	1919	1919	1903	1914	1914	1919	1919	1914	1919	1914	1914	1919	1919	1914	1919	1914	1919	
Unlimed (U) or Limed (L)	U	L	U	L	U	U	L	U	L	U	U	U	L	U	L	U	U	U	U	
GRAMINACEÆ.																				
Number of species	9	11	10	10	9	9	7	8	7	10	10	10	9	11	11	13	13	13	13	
1. <i>Agrostis vulgaris</i>	15.72	12.08	18.44	8.42	2.04	12.82	1.03	4.24	0.32	9.96	17.50	11.65	2.32	11.02	3.33	7.51	7.50	4.37	6.54	
2. <i>Aira caespitosa</i>	—	—	—	—	—	—	—	—	—	—	0.05	—	—	—	—	—	—	—	—	
3. <i>Alopecurus pratensis</i>	1.98	4.37	1.27	5.85	4.56	2.49	42.19	1.41	76.05	3.25	5.05	18.21	18.12	22.20	35.18	13.25	22.25	10.86	30.20	
4. <i>Anthoxanthum odoratum</i>	14.75	6.74	17.39	7.79	23.43	7.72	7.55	34.00	1.09	3.56	3.44	3.90	1.44	5.19	1.95	1.03	4.26	0.58	1.15	
5. <i>Arrhenatherum avenaceum</i>	0.11	0.32	0.42	1.35	0.95	0.25	0.02	3.09	—	0.05	1.61	24.09	39.90	17.26	20.47	3.69	7.89	4.05	4.58	
6. <i>Avena flavescens</i>	—	0.70	0.05	0.50	—	—	—	—	—	0.05	—	0.09	—	0.12	0.04	8.74	3.18	5.91	2.93	
7. " <i>pubescens</i>	0.11	4.95	0.21	7.61	—	0.04	—	—	—	0.05	0.11	—	—	0.08	0.12	1.71	3.31	6.17	10.12	
8. <i>Bromus mollis</i>	—	0.05	—	—	—	—	—	—	—	—	—	—	—	0.08	—	2.12	0.20	4.75	0.23	
11. <i>Dactylis glomerata</i>	9.33	6.90	11.27	23.19	0.14	1.01	—	0.57	0.13	36.90	33.84	7.52	0.29	9.19	10.31	11.82	15.79	9.70	12.46	
12. <i>Festuca ovina</i>	27.70	25.40	14.22	10.53	53.55	72.88	34.84	47.80	7.74	37.53	4.19	14.40	10.60	5.51	4.71	20.76	6.08	21.64	4.42	
14. <i>Holcus lanatus</i>	7.01	5.45	22.34	9.95	1.05	0.04	0.20	0.27	0.04	0.89	2.36	14.40	14.23	7.19	0.34	3.48	2.13	10.09	6.82	
15. <i>Lolium perenne</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.27	0.43	0.26	0.30	
16. <i>Poa pratensis</i>	0.62	3.78	0.42	1.80	7.67	1.22	12.57	0.35	12.75	0.31	0.43	0.83	1.14	1.67	3.90	0.75	0.55	0.45	0.62	
17. " <i>trivialis</i>	—	—	—	—	0.24	—	—	—	—	—	—	0.09	—	0.40	0.24	2.39	1.42	2.12	1.09	
Stalks, not determined	0.40	0.38	—	—	—	0.08	0.24	—	—	0.10	—	—	0.25	—	—	0.27	—	1.09	0.09	
Total	77.73	71.13	86.03	77.05	93.63	98.55	98.64	91.73	98.12	92.65	68.58	95.18	94.37	79.83	86.59	77.79	74.99	82.04	81.55	
LEGUMINOSÆ.																				
Number of species	0	2	0	2	1	0	0	0	0	1	0	1	1	1	1	4	2	3	1	
1. <i>Lathyrus pratensis</i>	—	0.54	—	0.36	—	—	—	—	—	0.05	—	0.46	0.93	0.08	0.81	9.09	6.00	6.23	4.70	
2. <i>Lotus corniculatus</i>	—	0.16	—	0.29	—	—	—	—	—	—	—	—	—	—	—	0.61	0.12	0.06	—	
4. <i>Trifolium pratense</i>	—	—	—	—	0.01	—	—	—	—	—	—	—	—	—	—	0.07	—	0.06	—	
5. " <i>repens</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Total	—	0.70	—	0.65	0.01	—	—	—	—	0.05	—	0.46	0.93	0.08	0.81	9.84	6.12	6.35	4.70	
MISCELLANEOUS SPECIES.																				
Number of species	8	10	5	10	5	6	2	2	3	5	5	6	10	8	11	14	15	12	15	
1 and 2. <i>Ranunculus acris</i> et <i>bulbosus</i>	0.06	1.24	—	2.03	—	—	—	—	—	—	—	—	—	—	—	0.96	4.74	0.51	2.12	
4. <i>Cerastium vulgatum</i>	—	0.76	—	0.86	—	—	—	—	—	—	—	0.05	0.17	0.16	0.73	0.41	0.28	0.06	0.25	
5. <i>Stellaria graminea</i>	—	0.05	—	0.16	—	—	—	—	—	—	—	0.09	—	0.12	0.28	0.07	0.04	—	0.05	
13. <i>Anthriscus sylvestris</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	0.72	0.28	1.95	3.01	0.51	2.76	
14. <i>Conopodium denudatum</i>	0.17	0.16	1.16	1.08	—	—	—	—	—	0.79	4.30	0.27	0.93	3.19	2.03	3.01	0.27	1.74	0.13	
15. <i>Hieracium sphondylium</i>	—	—	—	—	—	0.13	—	—	—	—	—	0.28	0.59	0.72	—	—	—	—	—	
16. <i>Pimpinella saxifraga</i>	—	0.05	—	0.05	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
17. <i>Galium verum</i>	0.17	—	—	—	4.37	0.38	0.32	—	0.23	—	—	—	—	—	—	—	—	0.06	0.47	
19. <i>Achillea millefolium</i>	0.44	0.86	0.21	1.67	0.01	0.08	—	—	—	0.16	0.16	0.46	0.04	0.44	0.24	1.64	1.38	2.18	1.18	
20. <i>Centauria nigra</i>	18.94	21.85	2.11	4.10	1.43	0.13	—	0.09	—	4.51	1.93	—	0.34	—	0.28	1.84	0.39	2.51	1.43	
26. <i>Taraxacum vulgare</i>	—	—	—	—	—	—	—	—	—	—	—	—	0.08	—	0.24	0.07	0.12	0.13	0.05	
27. <i>Tragopogon pratensis</i>	—	—	—	—	—	0.04	—	—	—	—	—	—	—	—	0.04	—	0.28	—	0.16	
29. <i>Plantago lanceolata</i>	—	—	—	—	—	—	—	—	0.05	—	—	—	0.04	—	0.08	0.20	0.24	0.13	0.06	
30. <i>Veronica chamaedrys</i>	—	—	—	—	—	—	—	—	—	—	—	—	0.04	—	0.08	0.21	0.20	0.26	0.31	
31. <i>Ajuga reptans</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.16	—	—	
32. <i>Prunella vulgaris</i>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.27	—	—	—	
34. <i>Rumex acetosa</i>	0.62	0.97	9.90	11.44	0.54	0.51	0.47	7.95	1.55	1.10	24.49	1.79	0.63	15.10	6.26	2.05	8.37	0.32	3.30	
35. <i>Luzula campestris</i>	0.34	0.49	0.21	0.05	0.01	—	—	—	—	0.10	0.05	—	—	0.08	—	0.07	0.12	—	0.03	
Traces of various species	0.11	0.05	0.16	0.07	—	0.04	0.02	0.04	0.05	0.10	0.16	0.09	0.04	—	0.16	—	0.08	0.06	0.05	
Total	20.85	26.48	13.75	21.51	6.36	1.31	0.81	8.08	1.88	6.76	31.09	3.03	3.62	20.09	12.37	11.07	18.65	9.11	13.44	
Undetermined	1.42	1.69	0.22	0.79	—	0.14	0.55	0.19	—	0.54	0.33	1.33	1.08	—	0.23	1.30	0.24	2.50	0.31	

Missing numbers of species not found in samples from these plots.

INDEX.

THE manner in which the experimental results are recorded in the monograph renders the ordinary alphabetical index unnecessary and of little value, the requisite guidance being provided by the detailed Table of Contents at the beginning.

Information with regard to the general effect of manuring on the *association of various species* should be sought in Chapter IVA, in which the different types of manures are grouped.

Information with regard to the particular effect of manuring on *individual species* is given in Chapter IVB, in which the species are arranged in alphabetical order.

Chapters IVA and IVB constitute the two main sections of the monograph, and in each a definite scheme is followed throughout for each plot or species concerned, as follows :—

CHAPTER IVA. EFFECT OF MANURES AND LIME ON INDIVIDUAL PLOTS.

Description of Manuring.

Present Condition of Plot (Unlimed).

- (a) Type of herbage.
- (b) Time of starting into growth.
- (c) Yield.
- (d) Number of species.
- (e) Relative proportions of *Graminaceæ*, *Leguminosæ*, and *Miscellaneous* plants.

Main Constituents of Association on Plot, and Other Species.

Outline of Principal Changes during the Experimental Period, 1877-1919.

- A. Variation in yield.
- B. Change in number of species.
- C. Changes in the personnel of the herbage.

Effect of Liming.

- A. On herbage and yield.
- B. On number of species.
- C. On personnel of herbage.

CHAPTER IVB. EFFECT OF MANURES AND LIME ON
INDIVIDUAL SPECIES.

Distribution of species.

Unlimed Plots.

Quantity of species present.

Types of manuring that encourage species.

Types of manuring that do not encourage species.

Limed Plots.

Effect of liming on quantity.

Summary of Above.

Position of Species in Plant Communities.

For figures showing the actual percentage of species present on the different plots, Tables II.-VI. should be consulted, and also the smaller tables given in Chapter IVA, showing the change in percentage of certain species during the course of the experimental period and also that due to liming.

193717

Agric.
Soil
B.

Author Brenchley, Winifred Elsie

Title Manuring of grass land for hay.

DATE.

NAME OF BORROWER.

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU

